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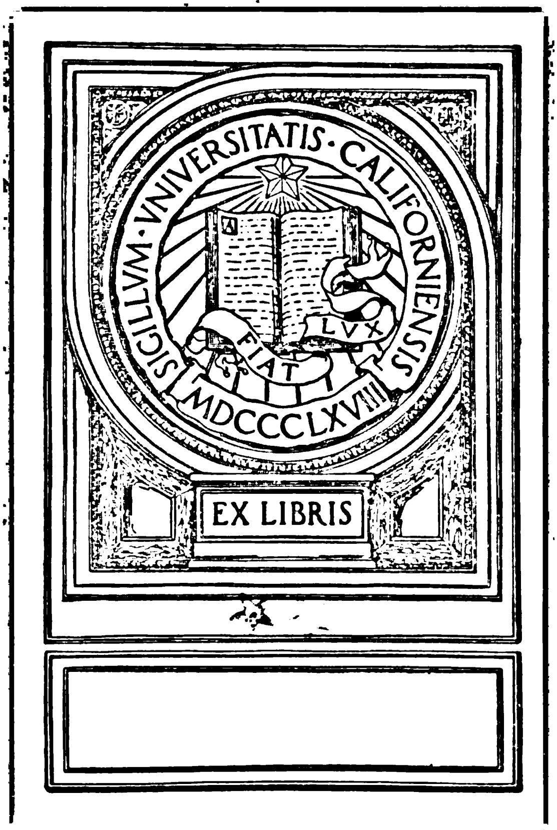
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INTRODUCTORY REPORT,

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WITH

GENERAL ESTIMATE,

ON THE PROPOSED

BRIDGE

ACROSS THE RIVER MERSEY, AT RUNCORN,

&c. &c.

By R. DODD, Engineer.

LONDON:
PRINTED BY S. GOSNELL, LITTLE QUEEN STREET,
HOLBORN.

1800.

HD

UNIV. OF CALIFORNIA

INTRODUCTORY REPORT,

&c.

To the Nobility, Gentry, and the commercially intereſted Inhabitants of the weſt Part of

LANCASTER AND CHESTER.

My Lords and Gentlemen,

AT the requeſt of ſeveral reſpectable gentlemen in both counties, and the contiguous parts, I have heretofore given my ſentiments, in a ſummary manner, of the practicability and importance of erecting a bridge acroſs the river Merſey, at a place called Runcorn Gap; the object of which is to ſave a circuitous paſſage, and thereby form a more direct and immediate communication with the weſt parts of the counties of Lancaſter and Cheſter: but they, conſidering the concern of great moment, and that many are intereſted therein, thought any information upon this ſubject ought not to be confined to a few individuals. They, therefore, requeſted me to make an ocular ſurvey, and treat the ſubject more at large, as I

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have endeavoured to do in the ſubſequent pages which I have the honour to lay before you.

Viewing the place where the bridge is propoſed to be erected, I found the deſign practicable and the ſituation extremely eligible; the hand of nature points out the ſpot, and favourably preſents us with a ſtrong rocky bottom for a foundation. I find this part of the river, from the Caſtle Rock on the Cheſhire ſide to the oppoſite ſhore, to be 412 yards; of courſe the bridge, from butment to butment, would be that length of line; but at low water the extreme width of the river in this place is only 294 yards; and an 18 feet tide at Liverpool only riſes 13 feet 4 inches at Runcorn.

The Caſtle Rock, at this place, is an excellent ſituation for the bridge to take its departure from, as well as the bold Lancaſhire ſhore on the oppoſite ſide.

To croſs the river Merſey near Runcorn, by means of the ferry-boat, is at any time more tedious and inconvenient than by a bridge, and in the boiſterous weather of the perilous months of winter is both difficult and dangerous; and at times impracticable: but the adoption of a bridge would obviate thoſe inconveniences, and render the paſſage at all times ſafe and certain; an advantage which thoſe who have frequent occaſion to croſs the river will beſt know the value of. It muſt cauſe the markets to be better and more regularly ſupplied, as farmers and others who bring proviſions will have a greater certainty of reaching their deſtination and of returning home in ſafety.

On obſerving the county maps of Lancaſter and Cheſter, I could diſcover no other way that paſſengers, carriages, cattle, &c. could paſs exempted from danger to the weſt part

part of each county, otherwiſe than by taking a very circuitous and tedious courſe, by way of Warrington. To elucidate my argument, I will take Liverpool and Cheſter for a datum, as the concluſions drawn from thoſe two places will apply to many others, according to their relative ſituation. By the preſent road, the diſtance from Cheſter to Liverpool is about 40 miles; by means of this bridge, 15 unneceſſary miles will be ſaved, and thereby reduce the length to only 25.

Conſidering the bridge in a more extended view, as it affects diſtant communications, we ſhall find that not only the preceding but other advantages will reſult from its execution, and that, in conſequence of it, the intercourſe between this diſtrict of the kingdom and North and South Wales muſt be greatly accelerated, and the roads much reduced; but the moſt material conſequence is the curtailing the diſtance from London to Liverpool, and the parts adjacent, the reſult of which is, letters would arrive by the mail two hours ſooner than at preſent; and by going out two hours later each day, leave more time to reply—an eſſential benefit to any place, but of the higheſt importance to a commercial town like Liverpool, which muſt give many conveniencies too numerous here to mention, and can be much better anticipated by the reſidents than any one elſe; as well as many other advantages that I have not noticed: but thoſe I have ſtated are very great, and I hope ſufficient to ſhow that a bridge is neceſſary and adviſable, both as a local and national improvement; and when I mention national improvement, it calls to my memory, and with pleaſure I reflect on what has been done in this part of the country, which has been like prolific ſeed thrown into a fertile ſoil, has yielded a large produce, and abundantly rewarded the ſower.

Whilſt many parts of this kingdom, for want of a cheap, certain, and eaſy conveyance by water, are labouring under the burden of a heavy land-carriage, which hinders an increaſe of commerce taking place, prevents manufactories from ariſing, valuable mines from being worked, and the comfort, happineſs, and convenience of the people being greatly increaſed; the town of Liverpool and this part of the country have long ſince thrown off that lethargy and indifference to their intereſt and public improvement; and not attending to the prejudice of cuſtom (and inſinuations of narrow minds, always ready, on thoſe occaſions, to depreciate projects that are for the general good), with a zeal worthy of imitation, at private expenſe, they have promoted and encouraged the making of many great and uſeful works; which have increaſed their agriculture, trade, commerce, and manufactories, to an extent aſtoniſhing beyond the moſt ſanguine expectations, and to a degree perhaps unparalleled in the ſame ſpace of time in any other part of the world: and it gives me pleaſure to hear there is an intention to make that accommodation which the growing trade and proſperity of the town of Liverpool demands; for I am well convinced that the more we encourage our marine, improve our harbours, and interſect the country with canals, and unite counties by roads and bridges over rivers, or tunnels under them, the nearer we are proceeding to perfection, and the more we are likely to keep that diſtinguiſhed pre-eminence we hold over all the nations of the earth for agriculture, commerce, &c.

Some

Some perſons may ſuppoſe, that to effect a permanent communication with Runcorn and the oppoſite ſhore a bridge is neceſſary, and nothing elſe can be adopted. The caſe is otherwiſe, and the ſituation is very favourable to a more novel but not leſs practicable deſign, which although it is not my intention to urge, I ſhould not requite you to the beſt of my knowledge, were I to refrain from obſerving, that by means of a road or tunnel under the bed of the river a communication may be effected from one ſide of the water to the other, which will poſſeſs many advantages over a bridge, be erected at a much leſs expenſe of time and money, be equally convenient for carriages, paſſengers, &c. perfectly ſafe, and require no repair for ages.

Some may admit that a tunnel under the river, could it be adopted, would be preferable to a bridge over it; but, from the procraſtination which has happened, the reports which have been circulated, and the accounts they have from time to time heard in the public papers, of the firſt propoſal of the ſort, may deſpair of the ſucceſs of the meaſure. However, for this there is no reaſon, as every candid perſon, informed of the particulars, muſt admit and ſay that the fault was in miſmanagement, in employing people poſſeſſed of more preſumption than abilities, and unacquainted with the art of mining, and not in any great difficulties that had taken place, or any appearance of impracticability that has occurred.

It may afford great ſatisfaction to thoſe intereſted in this, to the public, and others waiting the event, to underſtand that a complete change and inveſtigation has taken place, and that the concern is likely to be better conducted than heretofore. I have again taken the charge of the works, and overcome the pretended difficulties. The Committee have made great exertions, and put every thing in train for the further proſecution of the deſign with vigour.

I imagine every perſon well acquainted with this part of the country will approve of a bridge acroſs the river Merſey at Runcorn; I ſhall therefore proceed to mention the one I propoſe, with the ſum I recommend to be raiſed for its execution. It is evident it muſt be ſuch a one as will not obſtruct the navigation of the river, which can eaſily be avoided *.

Formerly

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* Places might be pointed out where it is important to have the navigation as free from obſtructions as poſſible, where thoſe ruinous bridges are permitted to remain an injury to the river over which they are erected, and a reproach to the town that permits them to ſtand; for inſtance, the metropolis of this kingdom is diſgraced by one, nothing leſs than a heap of rubbiſh held together at an enormous annual expenſe; which has brought many to a watery grave, is hazardous to paſs, whoſe contracted arches are the cauſe of making ſhoal water, and thus continually ſpoiling part of the fineſt river in the world; but I am happy to obſerve this public nuiſance is likely to be removed, and one more worthy the dignity and magnificence of the city of London to be erected, the Honourable the Houſe of Commons having, for theſe two laſt ſeſſions, had under conſideration my plans for the improvement of the port of London, ſome letters upon which were publiſhed in the year 1798, wherein I recommended the preſent bridge to be conſiderably improved, or otherwiſe taken down, and a new, elegant, and ſuitable one to be erected (two deſigns for which, among other of my plans, are now engraving, by their orders), capable of admitting ſhipping of 500 tons burden to paſs under their centre arch, and occupy the ſpace between London

Formerly ſtone bridges, with Gothic arches, were prevalent in this kingdom; now few are to be ſeen but what are in ruins or falling to decay. Thoſe ſorts of arches have given place to the elliptical, circular cycloidal, &c. all poſſeſſing the beauties of geometrical elementary generation; ſome prefer the one and ſome the other; and generally, when applied to practice, they exhibit beauty and ſtability. Within this laſt half century another ſpecies of bridges has ariſen amongſt us, before altogether unknown to the world, which go by the appellation of caſt-iron bridges, formed from a metallic ore, of which there are prodigious quantities in this iſland, which, from its cheapneſs and other qualities, renders it likely that many bridges of this ſort will be adopted in pre-

---

don and Blackfriars bridges, where there is room for near 1000 ſail, in the very centre of commerce; the river to be excavated where neceſſary, and quays to be built on each ſide of it, with fire-proof warehouſes above them, alongſide of which ſhipping may lie and diſcharge their cargoes with ſafety, as the ſame crane that takes the goods out of the hold would depoſit them in the ſtorehouſe above, and thus effectually prevent all depredation. This plan, unfortunately, came forward too late to be in the whole adopted, as others were too far advanced to be retracted from; however, it muſt give much pleaſure to the well-wiſhers of our marine accommodation, to underſtand that the advantages of the plan will be attended to, as a new bridge is intended to be built according to my original propoſal of admitting ſhipping to paſs under it, and lie between Blackfriars and London bridges; the quays and warehouſes on each ſide will follow of courſe, if not at public at private expenſe.

ference to other kinds. Are there any perſons ſolicitous to know where any of thoſe bridges alluded to are erected, let them turn their attention to Colebrook Dale, where are two acroſs the river Severn, both of which are very elegant ſtructures; another may be ſeen acroſs the river Wear at Sunderland: this latter eclipſes the two former in magnitude, being 236 feet ſpan, the others only 100 feet: they are all noble performances, great exertions of art, and an high honour to the country. Bridges of caſt-iron are erected with more facility than thoſe of ſtone, and at a much leſs expenſe of time and money. I am therefore induced to recommend a bridge of this deſcription at Runcorn, with three or five arches, and particularly as the ſtone on the ſpot is not well calculated for bridge-building; and to fetch it of a more tenacious and compact nature, from a greater diſtance, would create an unneceſſary expenſe. To carry the bridge into execution, I ſhould propoſe that 57,000*l.* be raiſed in transferable ſhares of 100*l.* each, payable by inſtalments, for which ſum a very ſuitable ſtructure may be reared, with its neceſſary roads, &c.

From the number of carriages, paſſengers, &c. that would uſe this bridge, a great revenue muſt ariſe. It is not my intention here to enter into details as to what amount this would be, as I have had no opportunity to make the neceſſary inquiries: but let any perſon reflect that all carriages are forced to go round by way of Warrington, in order to reach Liverpool and other places; and that many paſſengers do the ſame, in order to avoid the danger and uncertainty of the ferry, whoſe intereſt it would be to croſs this bridge, from the ſafety and certainty attendant upon it; and I think they will be ſatisfied it muſt be conſiderable, and that a ſmall toll will be ſufficient to produce an ample return to the ſhareholders who advance the capital for its execution, and that for a much greater ſum than 57,000*l.* were it neceſſary.

In endeavouring to point out from what the tolls would ariſe, I have only as yet directed your attention to ſuch ſources as they would immediately accrue from; but to judge from this would be adopting a criterion which (although ſufficient in the preſent caſe), in general, falls far ſhort of the amount; for thoſe concerns frequently turn out better than from a ſlight conſideration is expected.

At a place not more likely than this, Sunderland bridge acroſs the river Wear, the ferry produced 180*l.* per annum. Since a bridge has been erected, the toll has produced 1400*l.* the firſt year, and been increaſing ever ſince; a fact which ſhows the good effects of bridges better than any argument, and may not be unuſeful in computing the increaſe of the produce of the bridge under conſideration, which muſt be perpetually augmenting, from many cauſes, as the improvement of the country advances, as new roads are formed, and from the increaſe of population, trade, and commerce.

There is a reaſon why probably a bridge may be preferred to a tunnel at this place; that is, a bridge may be executed on ſuch a conſtruction as to admit of a canal aqueduct along its centre, with collateral roads on each ſide for the uſe of carriages, paſſengers, &c. This would exhibit one of the grandeſt ſpectacles in the world, the idea of which the reflecting mind will far better conceive than it is poſſible to deſcribe, as here, for the firſt time, would be the novel and magnificent ſight, of the tranſition of water and land traffic at one period over a great and navigable river 95 feet altitude from its ſurface. I will indulge the idea for a moment of the emulous and generous ſpirit of the country, laudably coming forward to execute this lucrative and ſplendid plan—what would probably be the beneficial reſult of its adoption? The continuation of the Duke of Bridgewater's canal, from Mancheſter to Liverpool, on one level, which will avoid the uncertain and perilous navigation of the lower part of the river Merſey, which, from its width, ſtrong tides, numerous and dangerous ſhoals, is little better than an arm of the ſea; likewiſe it would effect an inland communication from Liverpool, by canals already executed, executing, or intended, with London, Hull, and Briſtol: in ſhort, with the moſt material rivers and trading-places in this kingdom. To accompliſh this deſirable, provincial, and national improvement, the aggregate length of the canal, from Runcorn to Liverpool, would, I conceive, not exceed 13 or 14 miles, but probably leſs. To what extent the commercial intereſt of Liverpool is concerned in ſuch an undertaking is ſubmitted for their conſideration; I have here only to obſerve, that, when opportunity ſerves, I ſhall produce a more detailed and collective account of the utility, expenſe, &c. of this projected canal navigation.

I doubt not but the inhabitants of this part of the country, already ſo celebrated for the many excellent public works and improvements they have adopted, will proceed to the execution of a bridge at Runcorn, the deſign of which has originated among themſelves; that they will duly examine its importance public and

private,

private, and conſider, that the earlier they accompliſh it the ſooner they will advance their own intereſt, and execute a work much wanted, which ſhall be a monument of their good ſenſe, and remain, amongſt many others to their honour, a bleſſing to the preſent generation, and for which poſterity ſhall have to thank a people emulous for the public good, who, by example, have demonſtrated how the agriculture and commerce of this nation may be increaſed, and who have ſhone conſpicuous in thoſe uſeful purſuits which promote the general weal; by adopting ſuch works as have produced, in a great degree, what conſtitutes the excellency of any plan—public and private advantage.

That commerce, with its conſequences, is the baſis of national proſperity, no one ſurely will be ſo pertinacious as to deny; therefore, the moſt momentous conſideration is, the maintaining and augmenting the ſources from which ſo great a bleſſing to the commonwealth accrues. Hence are individuals and part of the community to be benefited—we ſhould with zeal abet every undertaking that partially tends to ſo noble and important a concluſion. Here bridges and canals claim attention as fountains from which flows wealth to the public weal; they give ſubſiſtence to the induſtrious indigent, they facilitate and encourage commerce, cauſe the culture of the ground, the eſtabliſhment of towns, manufactories, villages, &c. increaſe population, by multiplying the conveniencies of human life, and diffuſe univerſal bleſſings on every ſide.

I am, my Lords and Gentlemen,
Your very humble ſervant,

R. DODD.

35, *Whitehall, London.*

Printed by S. Gosnell,
Little Queen Street, Holborn.

Statutes

RELATING TO

SEWERS

WITHIN

THE JURISDICTION OF

THE COMMISSIONS

For the City and Liberty of Westminster and

Part of the County of Middlesex.

LONDON:
PRINTED BY JOHN SMITH, 49, LONG ACRE.

1839.

CONTENTS.

Page
Limits of the Commission xiii
Names of the Commissioners xiv

Ninth Henry Third, Magna Charta.

CAP. XV. MAKING OF BRIDGES AND BANKS... 1
CAP. XVI. DEFENDING OF BANKS 1
CAP. XXIII. IN WHAT PLACES WEARS SHALL BE PUT DOWN 1

Sixth Henry Sixth. CAP. V.—SEVERAL COMMISSIONS OF SEWERS SHALL BE GRANTED.—FORM OF THE COMMISSION.

(1) Commissions granted during Ten years 3
(2) Form of Commission..................................... 3
(3) To survey and inquire by whose Default Annoyances came 4
(4) To inquire who hath Lands, Common, or Fishing, or Loss by Annoyances, or Benefit by Repairs... 4
(5) To distrain for Reparations 5
(6) To spare none who may receive Benefit or Loss... 5
(7) Agistments on Sea Banks 5
(8) To take Account of Collectors........................ 5
(9) To distrain for Arrearages 6

Page.
(10) To make Ordinances for Defence of Sea Banks... 6
(11) To take Laborers to work in Reparations 6
(12) To survey Walls, Sewers, &c......................... 6
(13) Lest Dangers happen 7
(14) To punish those that refuse or neglect to repair 7
(15) To cause Ordinances to be observed 7
(16) Sheriffs and Jurors to be attendant on Commissioners 7

Eighth Henry Sixth. CAP. III.—COMMISSIONERS OF SEWERS MAY EXECUTE THEIR OWN ORDINANCES 9

Twelfth Edward Fourth. CAP. VII.—AN ACT FOR THE TAKING AWAY OF WEARS AND FISHGARTHES.

SEC.
I, II, III, (1 2 3 4) Preamble 11
(5) Confirmation of other Statutes...... 15
(6) Penalty for not performing Award 15

IV. (1) Penalty for continuing Offence 16
(2) Appropriation of Penalty 17
(3) How to be sued for............................. 17

Sec. Page.

V. (1) Process as in Action of Debt 17

(2) Defendant not to wage his Law 17

(3) No Protection of King's Service allowed ... 17

VI. (1) Penalty of Heir or Assignee continuing Offence 17

(2) Appropriation of Penalty 17

(3) Process as in Action of Debt 18

(4) Defendant not to wage his Law 18

(5) No Protection of King's Service allowed ... 18

Twenty-third Henry Eighth. Cap. V.—Bill of Sewers, with a new Proviso, &c. 19

I. (1, 2, & 3).—Preamble 19

(3) Commissions to be directed where needful . 20

II. (1) Form of Commission 20

(2 & 3) Causes of awarding Commission 21

III. (1) What Things Commissioners may do 21

(2) To inquire by whose Default Annoyances come 22

(3) To assess Persons contributary to the Charge. 22

(4) To amend and make-new the Sewers, &c.... 23

(5) To prostrate Obstructions 23

(6) To appoint Officers 23

(7) To distrain for Arrearages 24

(8) To take Labourers, Workmen, Carriages, &c. 24

(9) To take Timber, and other Necessaries ... 24

Sec. Page.
(10) To make Statutes and Ordinances 25
(11) To hear and determine all and singular the Premises 25
(12) To award Precepts to Sheriffs, &c. 25
(13) To continue Process of the same 25
(14) To survey Sewers, &c. 25
(15) To compel Others to obey their Orders ... 26
(16) To cause Ordinances to be observed 26
IV. (1) Fines, &c. saved to the King 26
(2) Sheriffs to return Jurors fit for Inquiry ... 27
(3) Officers shall be attendant to Commissioners 27
V. (1) All Commissioners named, to attend 27
(2) Commissioners to take an Oath 27
(3) Form of Oath 28
VI. Confirmation of other Statutes 28
VII. (1) Power to make Laws, Ordinances, &c. 29
(2) And to reform, repeal, and amend them ... 29
VIII. To decree Lands for non-payment of Charge 29
IX. Decrees to bind King's and Men's Lands ... 30
X. (1) Penalty on sitting, being unsworn, or without Qualification 31
(2) Appropriation of Penalty 32
XI. (1) Avowry of Distress, taken by Reason of Commission 32
(2) Reply of Plaintiff, Jury to try Issue 33
(3) Whole Matter to be given in Evidence ... 33

Sec. Page.

XII. Where Defendant shall recover Damages, with Costs 33

XIII. (1) Wages &c. of Commissioners, and Clerk. 33

(2) Allowances to Clerk, Collectors, &c....... 34

XIV. (1) Commissions within the Duchy 34

(2) Two Commissions to be awarded 34

XV. Charge of the Commissions.................. 35

XVI. (1) Commission to endure Three Years 35

(2) Commission, or Commissioner, discharged by *Supersedeas*............................ 35

(3) Commissioners have no Power after Discharge 36

XVII. How long Decrees shall endure 36

XVIII. Commissions into a County Palatine 36

XIX. (1) Royal Assent to Laws, &c. of Commissioners to be certified into the Chancery. 37

(2) Charge for Certificate 37

XX. (1) Commissions in Wales, and Counties Palatine. 37

(2) To be made out on Production of King's Commission 38

(3) Who are to be named Commissioners 38

(4) Act to endure Twenty Years 38

Sec. Page.

Third and Fourth Edward Sixth. Cap. VIII.—An Act for the continuance of the Statute of Sewers 39

I. (1) Preamble 39

(2) Stat. 23, Hen. 8, c. 5, made perpetual 39

II. (1) Rates on King's Lands leviable by Distress. 40

(2) Collectors' Receipt, Acquittance for Farmer 40

(3) Fees for Commissions under Seal of Duchy. 41

(4) Commissions to endure Five Years........ 41

Thirteenth Elizabeth. Cap IX.—An Act for the Commission of Sewers. 43

I. (1) Preamble 43

(2) Commission to endure Ten Years 43

(3) Orders shall be of Force without Certificate or Royal Assent 43

II. (1) Orders shall continue One Year, though Commission expire 44

(2) Justices of the Peace may, for One Year, execute the Commission 45

III. Power of Justices to cease, if a New Commission be granted........ 45

IV. (1) When a Farmer of Lands chargeable, may not be a Commissioner 46

(2) Such Commission to be void 46

Sec. Page.

V. There shall be no Certificate of Commissions, nor Ordinances, nor any Molestation of Commissioners 47

VI. (1 & 2) Fines, &c. shall be estreated into the Exchequer 47

(3) By the Clerk yearly 47

(4) Under Penalty of Five Pounds 48

VII. When a Farmer of Lands chargeable, may be a Commissioner 48

Third James First. CAP XIV.—AN ACT FOR THE EXPLANATION OF THE STATUTE OF SEWERS 49

I. (1 & 2) Preamble 49

II. Watercourses falling into the Thames, within Two Miles of London, subject to the Commission 50

Second William and Mary. SESS. II. CAP. VIII. AN ACT FOR PAVING AND CLEANSING THE STREETS IN LONDON AND WESTMINSTER, &c. &c.

XIV. New Sewers subject to the Commission 51

Sec. Page.

Seventh Anne. CAP X.—AN ACT FOR RENDERING MORE EFFECTUAL THE LAWS CONCERNING COMMISSIONS OF SEWERS 53

I. Preamble 53

For Non-payment of any Lot, Copyhold Lands may be decreed from their Owners. 54

II. Buyers of such Lands agreeing for Fines, the Lords to admit them Tenants 55

III. Assessments may be levied by Distress 56

Forty-seventh George Third. CHAP. VII. LOC. & PERS.—AN ACT TO ENLARGE THE POWERS AND EXTEND THE JURISDICTION OF THE COMMISSIONERS OF SEWERS, FOR THE CITY AND LIBERTY OF *WESTMINSTER*, AND PART OF THE COUNTY OF *MIDDLESEX* 57

Preamble 57

Jurisdiction extended to a Watercourse which divides Chelsea from Fulham, and to several Parishes 60

Power to widen, deepen, and alter, Sewers, and order making of New Ones 61

No Sewer to be made without Notice......... 62

Public Act 64

Sec. Page.

Fifty-second George Third. Loc. and Pers.

Cap. XLVIII.—An Act for empowering the Commissioners of Sewers for the City and Liberty of *Westminster*, and Part of the County of *Middlesex*, to purchase a Messuage and Premises, for holding their Meetings; and for enlarging the Powers of the said Commissioners 65

Preamble 65

I. Power to purchase Messuage in Greek-street 68

II. Power to borrow Money 70

Form of Assignment 70

III. Power to raise Money by Annuities 72

Form of Grant of Annuity 73

Purchase-money, &c. may be paid out of Monies in Hand 75

IV. Transfer of Assignments and Annuities 75

V. Payment of Creditors by Ballot 77

Power to borrow Money at lower Interest to discharge Securities at higher Rate 79

Power to inspect Books of Rates of Parishes 80

Distress not unlawful for Want of Form...... 81

Plaintiff not to recover without Notice, or after Tender of Amends........................ 81

Limitation of Actions 82

Former Acts to remain in Force 83

Cost and Charges of this Act 83

Sec. Page.

Public Act.. 84

Schedules to which this Act refers 85

Fourth and Fifth William Fourth. Cap. XCVI.—An Act to enable the Commissioners of Sewers, for the City and Liberty of Westminster and Part of the County of Middlesex, to make a new Sewer at Bayswater, in the County of Middlesex 87

Preamble 89

I. Commissioners to make a Wear and Sewer . 87

II. To enter upon Premises 90

III. To have same Powers as before this Act...... 90

IV. To borrow Money from Exchequer Loan Commissioners 91

V. Rate of Interest to be paid 91

VI. To levy Rates 92

VII. To assign Rates.................................. 93

VIII. Commissioners of Woods to advance One Moiety.. 93

IX. Distinct Account to be kept 94

Limits of the Jurisdiction of the Commissioners of Sewers for Westminster and Part of the County of Middlesex.

COMMISSIONS DATED 5TH DECEMBER, 1837.

The Parishes of Hampton, Teddington, Twickenham, Isleworth, Hanwell, Brentford, Acton, Ealing, Hammersmith, Fulham, Kensington, and Chelsea, in the County of Middlesex, and to and within the City and Liberty of Westminster, and Precincts of the same, and to Temple Bar in the said County, and from thence to and within the Parishes of St. Giles-in-the-Fields, and St. George, Bloomsbury, St. Pancras, St. Mary-le-bone Hampstead, Willesden, and Paddington, and so to the River Thames in the County aforesaid, or in the Borders or Confines of the same.

Commissioners of Sewers

FOR

Westminster,

AND PART OF MIDDLESEX.

1837.

The Archbishop of Canterbury, Lambeth Palace.

The Marquis of Lansdowne (President of the Council), 54, Berkeley square.

The Duke of Bedford, 6, Belgrave square.

The Duke of Devonshire, 78, Piccadilly.

The Duke of Portland, 19, Cavendish square.

The Duke of Northumberland, Strand.

The Duke of Wellington, Piccadilly.

The Marquis of Salisbury, 20, Arlington street.

The Marquis of Hertford, Park lane.

The Marquis of Exeter, 7, Albemarle street.

The Marquis of Camden, 71, Grosvenor street.

The Marquis of Clanricarde, 14, St. James's square.

The Marquis of Westminster, 33, Upper Grosvenor street.

The Earl of Shaftesbury, 24, Grosvenor square.

The Earl of Grosvenor, 15, Grosvenor square.

The Earl of Wilton, 7, Grosvenor square.
Lord Lyndhurst, 25, George street, Hanover square.
Lord Holland, Kensington.
Lord Southampton, 3, Carlton gardens.
Lord Kenyon, 9, Portman square.
Lord Kensington.
Lord Ravensworth, Percy cross, Fulham.
Lord Portman, 13, Hanover square.
Lord Worsley, 12, Belgrave street.
Honorable Philip Pleydell Bouverie, 16, Hill street.
Honorable Frederick Byng, 5, Cleveland court.
Sir Alexander Cray Grant, Bart., 16, Grosvenor street.
Sir Richard Sutton, Bart.
Sir William Curtis, Bart., 61, Portland place.
Sir John Dean Paul, Bart., 217, Strand.
Sir Henry Meux, Bart., 19, Great Russell street, Bloomsbury.
Sir Anthony Carlisle, 6, Langham place.
Sir George Farrant, 53, Upper Brook street.
Sir Peter Laurie, 7, Park square, Regent's park.
Sir John Scott Lillie, Kensington Gore
Sir Benjamin Charles Stephenson, (dead.)
Sir Francis Molyneux Ommanney, 21, Norfolk street, Strand.
Sir John Jacob Hansler, 48, Tavistock square.
The Very Rev. John Ireland, D.D., Dean of Westminster, Dean's yard.

The Rev. Robert Selby Hele, 34, Hunter street.
The Rev. Thomas White, Epperstone Rectory, Notts.
A'Beckett, William, 7, Golden square.
Adam, William George, 22, Lincoln's Inn fields.
Adams, William Dacres, Office of Woods.
Adey, Charles Francis, 6, Stone buildings, Lincoln's Inn.
Alexander, General James, 40, Nottingham place.
Allason, Thomas, 13, Great Cumberland street.
Amyot, Thomas, 13, James street, West.
Angell, Samuel, 2, Southampton street.
Arnold, Samuel James, 31, Golden square.
Bague, Captain George, 119, Sloane street.
Bandinel, James, Little cloisters.
Barke, George, 15, Queen's buildings, Brompton.
Barker, Richard, 14, Fitzroy square
Barlow, Frederick Pratt, Kensington.
Barry, Charles, 27, Foley street.
Bates, Edward, 13, Euston square.
Beach, William, 8, Sloane terrace.
Beachcroft, Samuel, 83, Cadogan place.
Bidwell, John, 2, Park place, St. James's.
Biffin, James, Rawstorne street, Kensington.
Boodle, Henry Mitford, 9, Davies street.
Bottomley, Thomas James, John street, Adelphi.
Bourdillon, Francis, 2, Montague street, Russell square.
Bradshaw, Augustus Hill, 27, Charles street, St. James's.
Branscombe, John, 88, Pall mall.

Broughton, Robert Edwards, 1, Melcombe place.
Brown, Joseph, 236, Regent's street
Bruce, William, 2, Paddington green.
Buck, George, Brighton.
Burgoyne, Thomas John, 21, Stratford place.
Burnand, William Henry, Kent House, Hampstead.
Byng, George, 5, St. James's square.
Calvert, Nicolson, 39, Harley street.
Cantwell, Robert, 20, Great Marlborough street.
Chalmers, Francis, 3, Cheyne row, Chelsea.
Chambers, Robert, 25, Lincoln's Inn.
Chawner, Thomas, 66, Guildford street.
Clark, William Tierney, Hammersmith.
Clay, William, 7, Nottingham place.
Cockerell, Charles Robert, Grove, Highgate.
Coles, William, Manor terrace, Chelsea.
Commerell, John William, 5, Berkeley street.
Conant, John Edward, 19, Upper Wimpole street.
Copland, Alexander, 4, Vincent square, Westminster.
Crace, Frederick, 14, Wigmore street.
Crawfurd, John, 27, Wilton crescent.
Cumberlege, Charles Nathaniel, 5, John street, Adelphi.
Cundy, Thomas, 13, Chester square, Pimlico.
Danvers, Frederick Dawes, Duchy of Lancaster Office.
Davies, Lieut.-Col. Wm. Bodycott, 44, Upper Harley street.
Deare, Charles, 8, King's Bench walk, Temple.
Donaldson, James, 8, Bloomsbury square.

Donaldson, Thomas Leverton, 7, Hart street, Bloomsbury.
Elliott, John Lettsom, Pimlico Lodge.
Elliott, Charles, 47, Portland place.
Eyre, Walpole, 22, Bryanston square.
Fane, Vere, 189, Fleet street.
Farlar, William, 48, Brompton square.
Faulder, Joseph, 15, Fitzroy square.
Fitch, John, Bath Cottage, Hammersmith.
Fitzgerald, Captain John George, Park walk, Chelsea.
Flood, Luke Thomas, Bellevue Lodge. Chelsea.
Flood, Luke Trapp, Bellevue Lodge, Chelsea.
Foxhall, Edward Martin, 18, South Audley street.
France, William Beckwith, 63, Cadogan place.
Fuller, Joseph, 42, Brewer street.
Goding, James, Belvedere road, Lambeth.
Goding, Thomas, Knightbridge.
Godrich, Francis, Little Chelsea.
Goldicutt, John, 39, Clarges street, Piccadilly.
Gotobed, Thomas, 82, Great Russell street, Bloomsbury.
Gowan, William,
Griffiths, William, 16, Edgware road.
Gunter, John, Fulham.
Gunter, Robert, Earl's court.
Gutch, George, Bridge House, Paddington.
Hachett, Charles, Bellevue House, Chelsea.
Hall, Benjamin Edward, Paddington green.
Hall, John,

Halswell, Edmund, Brompton park.
Hamilton, William Richard, Stanley grove, King's road.
Hamlet, Thomas, Sydney passage, Leicester square
Hardwick, Philip, 60, Russell square.
Harrison, Henry, 31, Park street, Grosvenor square.
Hawkes, William, High street, Kensington.
Heaton, Charles, 43, Mortimer street, Cavendish square.
Hebbert, Charles, (dead.)
Hodsoll, William Thomas, 46, Bedford row.
Holroyd, John, 23, Northumberland street, Strand.
Hope, John Thomas, 37, Upper Seymour street.
Hope, Thomas Henry, 37, Upper Seymour street.
Hume, Joseph, 6, Bryanston square.
Iggulden, John, 8, Russell square.
Jacobs, Joseph, Thistle grove, Little Chelsea.
Jennings, Richards, 21, Portland place.
Johnson, Thomas Heming, 22, College street, Chelsea.
Jones, Benjamin, Cheyne walk.
Kay, Joseph, 6, Gower street.
Kendall, Henry Edward, 17, Suffolk street, Pall mall East.
Knight, George, 95, Sloane street.
Lane, James, Cannonbury square, Islington.
Laurie, Peter, 7, Park square, Regent's park.
Lennard, John Barrett, 9, York gate, Regent's park.
Leslie, John, 60, Conduit street.
Leverton, William, 64, Lincoln's Inn fields.
Lewis, Thomas, Dean street, Soho.

Lewis, William Stone, 5, Sussex place, Regent's park.
Lock, Charles Molyneux, Upper Cheyne row.
Long, John Wakeman, 26, Hans place, Sloane street
Lowe, Robert, 16, Lower Seymour street.
M'Naughtan, William, 20, Beaumont street.
Maule, William, 19, Saville row
Mayhew, Charles, 14, Argyll street.
Mills, Samuel, 20, Russell square.
Milne, Alexander, Office of Woods, &c.
Mitchell, George Gardiner, Haslemere, Surrey
Moore, George, 64, Lincoln's Inn fields.
Morris, John, 21; Baker street.
Morris, Joseph, Northumberland House.
Mullins, Edward, Took's court, Chancery lane.
Mullins, George, Brook green, Hammersmith.
Mullins, John, Manor Cottage, King's road.
Mylne, William Chadwell, New River head.
Neeld, Joseph, 6, Grosvenor square.
Nurse, William Mountford, 5, Langham place.
Nutting, John George, 7, Stanhope terrace, Hyde park.
Owlett, Timothy, Milton street, Dorset square.
Panter, John Leach, Metropolitan Roads Office.
Penn, Richard, 6, Whitehall.
Pensam, John, 53, Gower street.
Pepys, John, 8, Lower Berkeley street.
Perry, William, 54, Tavistock square.
Perry, Thomas Erskine, 25, Chester street, Pimlico.

Phillott, Colonel Joseph, Kensington gore.
Price, Stafford, 31, St. Martin's lane.
Repton, George Stanley, 27, New Norfolk street.
Rhodes, Henry, 26, Margaret street.
Rhodes, Thomas, Hampstead road.
Richards, William Parry, 8, Wellington street, Strand.
Robins, George Henry, Great Piazza, Covent garden.
Rogers, Colin, 29, Dorset square.
Rudge, Edward, 44, Wimpole street.
Sale, Richard Cowleshaw, 21, Surrey street, Strand.
Saunders, George, (dead.)
Scott, George, Ravenscourt, Hammersmith.
Scott, William, 22, Grafton street.
Sculthorpe, George King,
Seward, Henry Hake, 10, South Audley street.
Sheppard, Thomas, Hampstead heath.
Slack, Joseph Albin, 46, Weymouth street.
Smith, Robert Vernon, 20, Saville row.
Smith, William, 33, Montague square.
Stark, Hugh, India Board.
Tuffnell, Henry, 13, Cavendish square.
Twining, Richard, 216, Strand.
Unwin, William, 90, Milton street, Dorset square.
Urquhart, William, Sudbury, Harrow.
Vale, John, 7, Devonshire place, Edgeware road.
Vines, Samuel, 47, Upper Gower street.
Ward, John, 4, Compton terrace, Islington.

Ware, Charles Hodges, 20, St. John's Wood road.
Ware, Samuel, 34, Portland place.
Watkins, George, Pimlico.
Watts, James, 13, College street, Westminster.
White, John, New road, Marylebone.
White, Richard, 14, Essex street, Strand.
White, William, Cannon row, Westminster.
Whitehead, Charles, 15, Milton street, Dorset square.
Wilmott. Henry, Lawrence street, Chelsea.
Willoughby, Edward, 4, Lancaster place, Strand.
Wood, Lancelot Edward, 10, Trevor square, Brompton.

ADDED—1838.

Thiselton, William Mathew, 59, Great Russell street.
Pratt, John Tidd, 5, Bolton street, Piccadilly.

EXTRACTS OF

Magna Charta, the Great Charter.

ANNO 9th HENRY III. A. D. 1225.

(Confirmed Anno 25, EDWARD I.)

CAP. XV.

Making of Bridges and Banks.

No Town or Freeman shall be distrained to make Bridges nor Banks, but such as of old Time and of Right have been accustomed to make them in the Time of King *Henry* our Grandfather.

2 Inst. 29.

CAP. XVI.

Defending of Banks.

No Banks shall be defended from henceforth, but such as were in defence in the Time of king *Henry* our Grandfather, by the same Places and the same Bounds, as they were wont to be in his time.

2 Inst. 30.
Post. c, 23.

CAP. XXIII.

In what Places Wears shall be put down.

All Wears from henceforth shall be utterly put down by *Thames* and *Medway*, and through all *England*, but only by the sea Coast.

Ante c. 16.
2 Inst. 38.
10 Co. 138.
25 Ed. 3. c. 4.
1 H. 4. c. 12.
12 Ed. 4. c. 7.

B

EXTRACT OF

Statutes made at Westminster,

ANNO 6th HENRY VI. A.D. 1427.

CAP. V.

Several Commissions of Sewers shall be granted.

The Form of the Commission.

Item, Our Sovereign Lord the King, by the Advice and Assent aforesaid, considering the great Damage and Losses which now late be happened by the great Inundation of Waters in divers Parts of the Realm, and that much greater Damage is very like to ensue if Remedy be not speedily provided, hath ordained and granted,(1) That during Ten Years next ensuing several Commissions of Sewers shall be made to divers Persons by the Chancellor of *England* for the time being, to be sent into all Parts of the Realm where shall be needful, according to the Form that followeth.

Commissions of Sewers shall be granted during Ten Years.

(2)Henry, by the Grace of God, King of England, &c. To his well beloved and faithful A, B, C, and D, greeting, Know ye, That whereas the Walls, Ditches, Gutters, Sewers, Bridges,

The Form of the Commission of Sewers. 23 H. 8. c. 5.

Causeys, and Wears, by the Coasts of the Sea and Marsh, within the Coasts and Limits of *Lindsey* in the County of *Lincoln*, by the Rage of the Sea flowing and re-flowing, and Trenches of fresh Waters by divers Places descending to the Sea, be so decayed and broken, that many inestimable Damages for Default of Reparation of the same Walls, Ditches, Gutters, Bridges, Causeys, and Wears, in Times past have happened there, and yet it is to be feared that much more Hurt within short Time will happen, unless that some speedy Remedy be provided therefore: (3) We, for as much by Reason of our regal Dignity we be bounden to have Regard to the Safety of our Realm of England in all Places, willing in this Behalf to provide convenient and speedy Remedy, have assigned you, &c. of which, &c. we will to be one, our Justices to survey the Walls, Ditches, Gutters, Sewers, Bridges, Causeys, Wears, and Trenches, (4) and to enquire by the Oath as well of Knights, as other good and lawful Men of the said County, as well within Liberties as without, by whom the Truth of the Matter may be best known, by whose Default such Damages have there happened, and who doth hold Lands and Tenements, or hath any Common of Pasture or Fishing, in those Parts, or else in any wise have, or may have, the Defence, Profit, and Safeguard, as well in Peril nigh, as from the same far off, by the said Walls, Ditches, Gutters,

Commissioners shall enquire of the Annoyances, and by whose default they happened.

Inquiry who hath Lands, Common or Fishing there, and who may have loss by the Annoyances, or benefit by the repair of them.

Sewers, Bridges, Causeys, and Wears, and also Hurt or Commodity by the same Trenches,(5) and there to distrain all them for the quantity of their Lands and Tenements, either by the number of Acres, or by their Plow Lands, for the rate of the Portion of their Tenure, or for the Quantity of their Common of Pasture or Fishing, together with the Bailiffs of Liberties, and other Places of the Counties and Places aforesaid, to repair the said Walls, Ditches, Gutters, Sewers, Bridges, Causeys, and Wears, in the Places necessary, and the same or other, as often and where shall be needful, to make of new, and to cleanse the said Trenches in Places necessary, and if Need be to stop them up,(6) so that no Tenants of Lands or Tenements, nor any having Common of Pasture or Fishing, rich or poor, nor other of what Condition, State, or Dignity, which have or may have Defence, Commodity, and Safeguard, by the said Walls, Ditches, Gutters, Sewers, Bridges, Causeys, or Wears, or else any Hurt by the said Trenches (whether they be within Liberties or without) shall in any wise be spared in this;(7) and for Agistments upon the Sea Banks for Preservation of the said Parts, according to the Number of the Acres or Perches by you, &c. of whom, &c. we will to be one, newly to number, and as often and where shall Need of new to make.(8) And to depute certain diligent and true Keepers for the said Preservation, and to

Distraining for reparations.

None shall be spared that may receive benefit or loss.
5 Co. 100.
10 Co. 141.
4 Mod. 350.

Taking the account of the Collectors.

hear the Account of the Collectors of the Money which shall be levied for this Cause, and to be spent in the Reparation and Amendment of the said Walls, Ditches, Gutters, Sewers, Bridges, Causeys, and Wears, and stopping of the said Trenches.(9) And to distrain by you, &c. of whom, &c. we will to be one, or by other whom ye shall thereto depute, for the Arrearages of such Collection as often as Need shall be, and as ye shall think meet,(10) and to make and ordain necessary and convenient Statutes and Ordinances for the Defence and Safety of the said Sea-Banks and Marshes, and the Parts adjoining, according to the Laws and Customs of *Romney Marsh*, and to hear and determine according to the Laws and Customs of our Realm of *England*, and the Custom of *Romney Marsh*, all and singular the Premises, as well at our Suit, as the Suit of any other that will complain before you in this Behalf;(11) and to take and put in the said Works and Reparations as many Ditchers and other Workmen and Laborers, for the said Workmanship and Reparations, as may suffice for the great, speedy, and instant, Necessity, upon competent Wages to them in this Behalf to be paid.(12) And therefore we command you, That at certain Days and Places which you, &c. of whom, &c. we will to be one, thereto shall appoint, ye shall survey the said Walls, Ditches, Gutters, Sewers, Bridges, Causeys, Wears, and Trenches,

Distraining for the arrearages of the Collection.

Making of Ordinances for the Defence of Sea Banks.

Taking of Laborers to work in the reparations.

and all and singular the Premises do and accomplish and hear and determine in Form aforesaid; (13) so that for Default of Reparation of the said Walls, Ditches, Gutters, Sewers, Bridges, Causeys, and Wears, and stopping of the said Trenches, no Hurt nor Peril shall in any wise happen. (14) And that ye compel all them whom ye shall find negligent or stubbornly denying to do Reparation or making of their Portions, speedily to reform and amend the same by Distresses and Amerciaments, and other Ways and Means which to you shall best seem for such Defaults; (15) and that ye cause all Things which by you shall be ordained in this Behalf, as well within Liberties as without, firmly to be observed, doing therein as to Justice pertaineth according to the Law and Custom of our Realm of *England*, saving to us the Amerciament and other Things thereof to us pertaining. (16) We have also commanded our Sheriff of the said County, that at certain Days and Places which you, &c. of whom, &c. we will to be one, shall give him to know, he shall cause to come before you, &c. of whom, &c. we will to be one, so many and such good and lawful Men of his Bailiwick, as well within Liberties as without, by whom the Truth of the Matter in the Premises may best be known and enquired. In Witness whereof, &c. Witness, &c.

Punishment of them which do neglect or refuse to repair their proportion assigned.

The Sheriffs and Jurors shall be attendant upon the Commissioners of Sewers.
8 H. 6. c. 3.
23 H, 6. c. 9.
6 H. 8 c. 10.
3 Jac. 1. c. 14.
7 An. c. 10.

EXTRACT OF

Statutes made at Westminster,

ANNO 8th HENRY VI. A.D. 1429.

CAP. III.

Commissioners of Sewers may execute their own Ordinance.

' ITEM, Our Lord the King, considering ' how at the last Parliament holden at Westminster, ' the Sixth Year of his Reign, he did ordain and grant, ' by authority of the said Parliament, That several ' Commissions of Sewers should be made to divers Persons ' by the Chancellor of *England* for the Time being, to be ' named, in all Parts of the Realm where shall be needful, ' under a certain Form in the said Ordinance and Grant ' contained: (2) by which Ordinance and Grant the said ' Commissioners had no Power nor Authority to do, ' perform, nor execute, the Things comprised within the ' said Commissions; (3) ' and therefore he hath ordained and established by Authority of this Parliament, That all such Commissioners shall have Power to do, ordain, and execute, the Statutes, Ordinances, and other Affairs, to be made according to the Effect and Purport of the said Commissions.

6 H. 6. c. 5.

The Commissioners of Sewers shall have power to execute their Ordinances.

EXTRACT OF

Statutes made at Westminster,

ANNO 12 EDWARD IV. A. D. 1472.

CAP. VII.

An Act for the Taking away of Wears and Fishgarthes.

'ITEM, **Whereas** by the laudable Statute 'of Magna Charta, amongst other Things it is 'contained, that all Kedels by *Thamise* and *Medway*, and throughout the Realm of *England*, 'shall be taken away, saving by the Sea-Banks, '(2) which Statute was made for the great 'Wealth of all this Land, in avoiding the Straitness of all 'Rivers, so that Ships and Boats might have in them their 'large and free Passage, and also in Safeguard of all the 'Fry of Fish spawned within the same; (3) upon which 'Magna Charta, the great Sentence and Apostolick Curse, 'by a great Number of Bishops was pronounced against the 'Breakers of the same, and the same Sentence is Four Times 'in the Year openly declared, according to the Law 'of the Holy Church; (4) and in Affirmance of the 'said Statute of the Great Charter, divers Statutes have been 'after made and ordained, amongst which, in a Parliament

Statutes that have been made for the pulling down or reforming of Wears, and of the Commissioners' authority. 9 H. 3. Stat. 1. c. 23.

1 H. 4. c. 12. 25 Ed. 3. Stat. 4. c. 4.

‘ holden in the First Year of the usurped Reign of King Henry ‘ the Fourth, it was recited, That in the Twenty-Fifth Year ‘ of King Edward the Third, Progenitor of our Lord the ‘ King that now is, because that the common Passages ‘ of Ships and Boats in the great Rivers of England, were ‘ oftentimes disturbed by levying of Wears, Mills, Mill-‘ stanks, Stakes, and Kedels, to the great Damage of the ‘ People, (5) it was ordained and established, that all such ‘ Wears, Mills, Millstanks, Stakes, and Kedels, which ‘ were levied and set up in the Time of King Edward, ‘ Son of King Henry, and after, in such Rivers (whereby ‘ the Ships and Boats were disturbed that they could not ‘ pass as they were wont) should be taken away and broken ‘ down, never to be set up again ; (6) and that Writs should ‘ be thereupon sent to the Sheriff of such Places where ‘ Need should be, to survey and enquire, and the same to ‘ execute ;(7) and that Justices should be thereto assigned at ‘ all Times when Need requireth. (8) And after grievous 45 Ed 3. c. 2.} ‘ Complaint, both of great Men, and of ‘ the Commons, thereupon made in the Parliament of the ‘ said King Edward the Third, in the Five and Fortieth ‘ Year of his Reign, shewing by their Petition, that the said ‘ Statute was not duly executed nor observed according to ‘ the Form and Effect thereof; it was accorded and esta-‘ blished, that the same Statute in that Point should be ‘ holden and kept according to the Tenor of the same ; (9) ‘ adjoined thereto, that if any such Annoyance be done, that 'the same be broken down by due Process contained in 'the said Statute,(10) and that he which again doth levy such 'Annoyances, and be thereof duly attainted, shall run in 'the Pain of an Hundred Marks to our Lord the King, to be 'levied by the Estreats of the Exchequer: (11) the same Law 'shall be holden of Annoyance made by the enhansing of 'the said Wears, Mills, Millstanks, Stakes, and Kedels, as 'by new levying, as in the said Statutes more plainly 'appeareth. (12) And then, at the request of the said 'Commons, shewing by their Petition, that the common 'Passages of Ships and Boats in the great Rivers of '*England*, and also Meadows and Pastures, and arable 'Lands, adjoining to the said Rivers, were greatly disturbed, drowned, wasted, and destroyed, by the outrageous enhansing and straitening of Wears, Mills, Millstanks, Stakes, and Kedels, made in old Time, and levied 'before the Time of the said King Edward, Son to the said 'King Henry, whereby great Loss and Damage often 'ensued to the People of the Realm, and daily would ensue 'if Remedy were not provided.

II. '**Wherefore it was Ordained and Enacted**, 'by the Assent of the said Parliament, holden the First 'Year of the said pretensed King Henry the Fourth, That 'the said Statutes in all their Articles should be observed, 'firmly kept, and duly executed; (2) adjoining thereto, that 'Commissions should be made in due Form to sufficient

‘ Persons to be Justices in every County of *England*, where ‘ Need should be, to survey and keep the Waters and ‘ great Rivers there, and to correct and amend the Faults ‘ and to make due Execution by the said Statutes, according to the Effect of the same,(3) as well by their Survey, ‘ Advice, and Discretion, as by Inquests to be taken thereof, ‘ within Franchise and without, when Need shall be, and to ‘ hear and determine all those Things aforesaid ;(4) and ‘ moreover to survey the Wears, Mills, Millstanks, Stakes, ‘ and Kedels, made in old Time, and levied before the said ‘ Time of King Edward, Son to King Henry ; and such as ‘ they find too much enhansed or straited, to correct, ‘ break down, and amend, in the Manner and Form ‘ aforesaid.

III. ‘ **Saving always**, a reasonable Substance of ‘ the same Wears, Mills, Millstanks, Stakes, Kedels, so ‘ made in old Time and levied.(2) And if any such Annoyances of Wears, Mills, Millstanks, Stakes, and Kedels, in ‘ letting of the Passages and straiting, made in old Time ‘ and levied, be judged or considered by the said Justices to ‘ be broken down or amended, he that hath the Freehold ‘ of the same shall do Execution thereof at his own Costs, ‘ within half a Year after Knowledge given to him, upon ‘ Pain of Forfeiture of an Hundred Marks, to be paid to our ‘ Lord the King by Estreats in the Exchequer ;(3) and he ‘ that doth levy them again, enhanse, or strait them, con-

'trary to the said Judgment, and thereof be duly convict, 'shall run in Pain of an Hundred Marks, to be paid to our 'Lord the King by Estreats in the Exchequer aforesaid, as 'in the same Statutes more fully appeareth. (4) Contrary to 'which Great Charter, and all the Statutes aforesaid, in 'divers Parts of this Realm of *England*, both in the destroying of the Fish, as afore is said, and in Disturbance of the 'Passages of Ships, Barges, Boats, and other Vessels, by 'divers and many People, divers Fishgarthes, Mills, Milldams, Millstanks, Locks, Ebbing Wears, Stakes, Kedels, 'Hecks, or Floodgates, and divers other Disturbances, be 'daily enhansed, levied, and enlarged, to the great 'Damage of our Lord the King, and of his faithful Lieges:' (5) our said Lord the King graciously considering the Premises, by the Advice and Assent of the Lords Spiritual and Temporal, and at the Request of the said Commons, in this Parliament assembled, and by Authority of the same, hath ordained and established, that the said Statute of the Great Charter, and all other Statutes concerning the Premises, shall be duly observed and kept; (6) adjoining thereto, that if, after the Feast of St. Michael, which shall be in the Year of our Lord God 1475, by Award, Rule, or Judgment, of any of the said Commissioners assigned according to the said Statute made in the said First Year of King Henry the Fourth, it be found that any such Wears, Fishgarthes, Mills, Milldams, Millstanks, Locks,

A Confirmation of all Statutes made for the pulling down of Wears. 10 Co. 138.

Ebbing Wears, Stakes, Kedels, Hecks, or Floodgates, be made, levied, enhansed, straited, or enlarged, against the same Statute, the Offenders in this Behalf contrary to the foresaid Award, Rule, and Judgment, being duly warned by the Sheriff or Sheriffs, by *Scire Facias* directed to the Sheriff or Sheriffs of such County or Counties where such Wears, Fishgarthes, Mills, Milldams, Millstanks, and other Noyances, Disturbances, or Impediments, be, and within Three Months next after the said Garnishment made, they do not duly and wholly amend, break down, and avoid, the said making, levying, enhansing, straiting, or enlarging, being defective, as afore is said, in the said Statute made in the said First Year, that then he or they, being defective in this Behalf, shall forfeit to our Lord the King an Hundred Marks, to be paid by Estreats in the Exchequer in Manner and Form as in the same Statute more fully is contained.

The Penalty of an Offender that doth not perform the Award of Commissioners authorized by the Statute of 1 H. 4. c. 12.

IV. Moreover, if the said Offender, or his Heir or Heirs, Assignee of Assignees, or any of them, do defer or continue the same Default, contrary to the Award, Rule, or Judgment, of the Commissioners aforesaid, that he or they so doing, deferring, or continuing, the said Default, shall forfeit, for every Month after the said Three Months ended that the same Default shall remain, and be not

The Penalty of him which doth continue in his Offence, or doth delay to reform it corrected, amended, nor reformed, an Hundred Marks,(2) the One Half thereof to our Lord the King, and the other Half to any of his Liege People which in this behalf will sue for the same,(3) by Action of Debt to be conceived by original Writ, without Fine to be made or taken for the same in the Chancery.

V. **In which Action**, like Process, Rule, Judgment, and Execution, shall be allowed, had, and made, as is used in other Actions of Debt pursued at the Common Law by Writ;(2) and that the Defendant in any such Action be not admitted to do or wage his Law,(3) nor that any Protection or Essoin of the King's Service be allowed for the Defendant in the same Writ.

The Penalty of the Heir or Assignee of the Offender that continueth the same offence.

VI. **Moreover**, it is ordained and established by the same Authority, that if any Person or Persons, other than such against whom such Award, Rule, or Judgment, were made and had, being Heir or Assignee to them, or any of them, do presume to occupy or continue any such Wears, Fishgarthes, Mills, Milldams, Millstanks, Locks, Ebbing Wears, Stakes, Kedels, Hecks, Floodgates, or other Disturbances or Impediments as afore is said, he or they so presuming to occupy or continue, shall forfeit at every Default, for every Month, as is aforesaid, an Hundred Marks,(2) the One Half to our Lord the King, and the other Half to him of the King's Liege People that will in this Behalf sue, by Action of Debt thereupon to be conceived, without paying any Fine for the same, as is aforesaid;(3) in which Action like Process, Rule, Judgment, and Execution, shall be used and made, as in all other Actions of Debt pursued at the Common Law by Writ is used;(4) and that the Defendant in any such Action shall not be admitted, nor in any wise received, to wage or do his Law;(5) nor any manner Protection or Essoin of the King's Service be for such Defendant in any wise allowed.

EXTRACT OF

Statutes made at Westminster,

ANNO 23 HENRY VIII. A.D. 1531.

CAP. V.

The Bill of Sewers, with a New Proviso, &c.

How far the Commission of Sewers shall extend.
Latch. 170. 171.
4 Inst. 275.
6 H. 6. c. 5.
8 H. 6. c. 3.
4 H. 7 c. 1.
6 H. 8. c. 10.

‘Our Sovereign Lord the King, like a virtuous and most gracious Prince, nothing earthly so highly weighing as the advancing of the common Profit, Wealth, and Commodity, of this his Realm, considering the daily great Damages and Losses which have happened in many and divers Part of this his said Realm, as well by the Reason of the outrageous Flowings, Surges, and Course, of the Sea, in and upon Marsh-grounds and other low Places, heretofore through politic Wisdom won and made profitable for the great Commonwealth of this Realm; as also by occasion of Land Waters and other outrageous Springs, in and upon Meadows, Pastures, and other low Grounds, adjoining to Rivers, Floods, and other Water Courses: (2) And over that, by and thro' Mills, Mill-dams, Wears, Fish-garths, Kedels, Gores, Gotes, Flood-gates, Locks, and other Impediments, in and upon the same Rivers and other

' Water-courses, to the inestimable Damages of the Common-wealth of this Realm, which daily is likely more ' and more to increase, unless speedy Redress and Remedy ' be in this Behalf shortly provided: (3) Wherein, albeit ' that divers and many Provisions have been before this ' Time made and ordained, yet none of them are sufficient ' Remedy for Reformation of the Premises,' Hath therefore, by deliberate Advice and Assent of his Lords Spiritual and Temporal, and also his loving Commons, in this present Parliament assembled, **ordained, established,** and **enacted,** That Commissions of Sewers, and other the Premises, shall be directed in all Parts within this Realm, from Time to Time, where and when Need shall require, according to the Manner, Form, Tenor, and Effect, hereafter ensuing, to such substantial and indifferent Persons as shall be named by the Lord Chancellor and Lord Treasurer of *England*, and the Two Chief Justices, for the Time being, or by Three of them, whereof the Lord Chancellor to be One.

The form of the Commission of Sewers.

II. ' HENRY the Eighth, &c. **Know** ' **ye,** That forasmuch as the Walls, Ditches, ' Banks, Gutters, Sewers, Gotes, Calcies, Bridges, ' Streams, and other Defences, by the Coasts of the Sea ' and Marish-ground, lying and being within the Limits ' of *A. B.* or *C.* in the County or Counties of

' or in the Borders or Confines of the

'same, by Rage of the Sea flowing and re-flowing, and by 'Mean of the Trenches of fresh Waters descending 'and having Course by divers Ways to the Sea, be so 'dirupt, lacerate, and broken; (²) and also the 'common Passages for Ships, Balengers, and 'Boats, in the Rivers, Streams, and other 'Floods, within the Limits of *A. B.* or *C.* in the County 'or Counties of 'or in the Borders or Confines of the same, by Mean of 'setting up, erecting, and making, of Streams, Mills, 'Bridges, Ponds, Fish-garths, Mill-dams, Locks, Hebbing-wears, Hecks, and Flood-gates, or other like Lets, 'Impediments, or Annoyances, be letted and interrupted, 'so that great and inestimable Damage for Default of 'Reparation of the said Walls, Ditches, Banks, Fences, 'Sewers, Gotes, Gutters, Calcies, Bridges, and Streams; '(³) and also by Mean of setting up, erecting, making, and 'enlarging, of the said Fish-garths, Mill-dams, Locks, 'Hebbing-wears, Hecks, Flood-gates, and other like Annoyances, in Times past, hath happened, and yet it is to 'be feared that far greater Hurt, Loss, and Damage, is 'like to ensue, unless that speedy Remedy be provided 'in that Behalf.

The several Causes of awardingth Commission of Sewers.

III. '**We therefore**, for that, by Reason 'of our Dignity and Prerogative Royal, we be 'bound to provide for the Safety and Preservation of our Realm of *England*, willing that

What things the Commissioners of Sewers are authorised to do. 13 Co. 36.

'speedy Remedy be had in the Premises, have assigned 'you and Six of you, of the which we will that *A. B.* 'and *C.* shall be Three, to be our Justices, to survey the 'said Walls, Streams, Ditches, Banks, Gutters, Sewers, 'Gotes, Calcies, Bridges, Trenches, Mills, Mill-dams, 'Flood-gates, Ponds, Locks, Hebbing-wears, and other Impediments, Lets, and Annoyances, aforesaid, and the same 'cause to be made, corrected, repaired, amended, put down, 'or reformed, as Case shall require, after your Wisdoms 'and Discretions; (2) and therein as well to ordain and 'do, after the Form, Tenor, and Effect, of all and singular 'the Statutes and Ordinances, made before the First Day 'of *March*, in the Three and Twentieth Year of our Reign 'touching the Premises or any of them; as also 'to inquire, by the Oaths of the honest and lawful Men of the said Shire or Shires, Place or 'Places, where such Defaults or Annoyances be, as well 'within the Liberties as without, (by whom the Truth may 'the rather be known) through whose Default the said Hurts 'and Damages have happened, and who hath or holdeth 'any Lands, or Tenements, or Common of Pasture, or 'Profit of Fishing, or hath or may have any Hurt, Loss, 'or Disadvantage, by any Manner of Means, in the said 'Places, as well near to the said Dangers, Lets, and Impediments, as inhabiting or dwelling thereabouts, by the 'said Walls, Ditches, Banks, Gutters, Gotes, Sewers, 'Trenches, and other the said Impediments and Annoyances; (3) and all those Persons, and every of

Inquiry by whose Defaults the Annoyances come.

Assessing the Persons

'them, to tax, assess, charge, distrain, and 'punish, as well within the Metes, Limits, and 'Bounds, of old Time accustomed, or otherwise, 'or elsewhere, within our Realm of *England*, 'after the Quantity of their Lands, Tenements, and Rents, 'by the Number of Acres and Perches, after the Rate of 'every Person's Portion, Tenure, or Profit, or after the 'Quantity of their Common of Pasture, or Profit of Fishing, or other Commodities there, by such Ways and 'Means, and in such Manner and Form, as to you, or Six 'of you, whereof the said *A. B.* and *C.* to be Three, 'shall seem most convenient to be ordained and done for 'Redress and Reformation to be had in the Premises; (4) 'and also to reform, repair, and amend, the said Walls, 'Ditches, Banks, Gutters, Sewers, Gotes, Calcies, Bridges, 'Streams, and other the Premises, in all Places needful; 'and the same as often, and where need shall be, to make 'new, and to cleanse, and purge, the Trenches, Sewers, and 'Ditches, in all Places necessary; (5) and further to reform, amend, prostrate, and overthrow, all such Mills, 'Streams, Ponds, Locks, Fish-garths, Hebbing-wears, 'and other Impediments and Annoyances aforesaid, as 'shall be found, by Inquisition or by your Surveying 'and Discretions, to be excessive or hurtful; (6) and also 'to depute and assign diligent, faithful, and 'true, Keepers, Bailiffs, Surveyors, Collectors, 'Expenditors, and other Ministers, and Officers,

to be contributary to the charge.
10 Co. 139. 141.
2 Bulstr. 199.
Cro. Jac. 336.

Appointing of Bailiffs, Collectors, Surveyors, & other inferior Officers.

‘ for the Safety, Conservation, Reparation, Reformation, and making, of the Premises, and every of them, and to hear the Account of the Collectors, and other Ministers, of and for the Receipt and laying out of the Money that shall be levied and paid, in and about the making, reforming, repairing, and amending, of the said Walls, Ditches, Banks, Gutters, Gotes, Sewers, Calcies, Bridges, Streams, Trenches, Mills, Ponds, Locks, Fish-garths, Flood-gates, and other Impediments and Annoyances aforesaid; (7) and to distrain for the Arrearages of every such Collection, Tax, and Assess, as often as shall be expedient, or otherwise to punish the Debtors and Detainers of the same, by Fines, Amerciaments, Pains, or other like Means, after your good Discretions; (8) and also to arrest and take as many Carts, Horses, Oxen, Beasts, and other Instruments necessary, and as many Workmen and Labourers, as for the said Works and Reparations shall suffice, paying for the same competent Wages, Salary, and Stipend, in that Behalf; (9) and also take such and as many Trees, Woods, Underwoods, and Timber, and other Necessaries, as for the same Works and Reparations shall be sufficient, at a reasonable Price, by you, or Six of you, of the which we will that *A. B.* and *C.* shall be Three, to be assessed or limited as well within the Limits and Bounds aforesaid as in any other Place within the said County or Counties

Distraining for the Arrearages of the Money assessed.

Taking of Labourers, Workmen, & Carriages.

Timber and other Necessaries.

To make Statutes and Ordinances.

'near unto the said Places; (10) and to make 'and ordain Statutes, Ordinances, and Provi'sions, from Time to Time, as the case shall require, for 'the Safeguard, Conservation, Redress, Correction, and 'Reformation, of the Premises, and of every of them, and 'the Parts lying to the same necessary and behooful, after 'the Laws and Customs of *Rumney Marsh*, in the County 'of *Kent*, or otherwise by any Ways or Means after your 'own Wisdoms and Discretions; (11) and to hear and de'termine all and singular the Premises, as well at our 'Suit as at the Suit of any other whatsoever, complaining 'before you, or Six of you, whereof *A. B.* and *C.* shall be 'Three, after the Laws and Customs aforesaid, or other'wise by any other Ways or Means, after your Discre'tions; (12) and also to make and direct all 'Writs, Precepts, Warrants, or other Com'mandments, by virtue of these Presents, to all 'Sheriffs, Bailiffs, and all other Ministers, Officers, and 'other Persons, as well within Liberties as without, be'fore you, or Six of you, whereof the said *A. B.* and *C.* 'to be Three, at certain Days, Terms, and Places, to be 'prefixed, to be returned and received; (13) and further 'to continue the Process of the same, and finally to do all 'and every Thing and Things as shall be requisite for the 'due Execution of the Premises, by all Ways and Means 'after your Discretions; (14) and therefore we command 'you, that at certain Days and Places, when and where

Awarding of Writs and Precepts to Sheriffs, Bailiffs, and others.

To compel others to obey their Orders. 2 Bulstr. 198.

‘ ye, or Six of you, whereof the said *A. B.* and *C.* to be Three, shall think expedient, ye do survey the said Walls, Fences, Ditches, Banks, Gutters, Gotes, Sewers, Calcies, Ponds, Bridges, Rivers, Streams, Water-courses, Mills, Locks, Trenches, Fish-garths, Flood-gates, and other the Lets, Impediments, and Annoyances, aforesaid, and accomplish, fulfil, hear, and determine, all and singular the Premises in due Form, and to the Effect aforesaid, after your good Discretions; (15) and all such as ye shall find negligent, gainsaying, or rebelling, in the said Works, Reparations, or Reformations, of the Premises, or negligent in the due Execution of this our Commission, that ye do compel them by Distress, Fines, and Amerciaments, or by other Punishments, Ways, or Means, which to you, or Six of you, whereof the said *A. B.* and *C.* shall be Three, shall seem most expedient, for the speedy Remedy, Redress, and Reformation, of the Premises, and due Execution of the same: (16) and all such Things as by you shall be made and ordained in this Behalf, as well within Liberties as without, ye do cause the same firmly to be observed, doing therein as to our Justice appertaineth after the Laws and Statutes of this our Realm, and according to your Wisdoms and Discretions.

IV. ‘ **Saved always** to Us such Fines and Amercia-

‘ ments as to Us thereof shall belong, (2) and
‘ we also command our Sheriff or Sheriffs of our
‘ said County or Counties of
‘ that they shall cause to come before
‘ you, or Six of you, of the which *A. B.* and *C.* to be
‘ Three, at such Days and Places as ye shall appoint to
‘ them, such and as many honest Men of his or their
‘ Bailiwick, as well within the Liberties as without, by
‘ whom the truth may best be known, to inquire of the
‘ Premises, (3) commanding also all other Min-
‘ isters and Officers, as well within Liberties as
‘ without, that they and every of them shall be
‘ attendant to you in and about the due Execution of this
‘ our Commission: **In Witness whereof,** we have
‘ caused these our Letters Patent to be made. Witness
‘ Ourself at *Westminster*, the Day of
‘ in the Year of our Reign.’

Sheriffs to return before the Commissioners such Jurors as shall be fit for Inquiry.

All other Officers shall be attendant to the Commissioners.

V. **And it is also Enacted,** That every such Person as shall be named Commissioner in the said Commission, after he hath knowledge thereof, shall effectually put his Diligence and Attendance in and about the Execution of the said Commission; (2) and before he shall take upon him the Execution of the said Commission, he shall take a Corporal Oath before the Lord Chancellor, or before such to whom the said Lord Chancellor shall direct the King's Writ of *Dedimus Po-*

The Commissioners shall take an Oath. Enforced by 25 H. 8. c. 10.

testatem to take the same, or before the Justices of the Peace, in the Quarter Sessions holden in the Shire, where such Commissions shall be directed: The Tenor of which Oath hereafter ensueth. (3)

The Form of the Oath.

"Ye shall swear, that you, to your Cunning, Wit, and Power, shall truly and indifferently execute the Authority to you given by this Commission of Sewers, without any Favor, Affection, Corruption, Dread, or Malice, to be borne to any Manner of Person or Persons: and, as the Case shall require, ye shall consent and endeavour yourself for your Part, to the best of your Knowledge and Power, to the making of such wholesome, just, equal, and indifferent, Laws and Ordinances, as shall be made and devised, by the most discreet and indifferent Number of your Fellows, being in Commission with you, for the due Redress, Reformation, and Amendment, of all and every such Things as are contained and specified in the said Commission: and the same Laws and Ordinances, to your Cunning, Wit, and Power, cause to be put in due Execution; without Favour, Meed, Dread, Malice, or Affection, as God you help, and all Saints."

A Confirmation of other Statutes.

VI. And it is also Enacted, by the Authority aforesaid, That all and every Statute, Act, and Ordinance, heretofore made concerning the Premises, or any of them, as well in the Time of our Sovereign Lord the King that now is, as in the Time of any of his

Progenitors, Kings of this Realm of *England*, not being contrary to this present Act, nor heretofore repealed, from henceforth shall stand, and be good and effectual for ever, and to be put in due Execution according to the true Meaning and Purport of the same.

The Authority of the Commissioners.

VII. **And over that it be Enacted,** That the Commissioners hereafter to be named in any of the said Commissions, according to the Purport and Effect of the same Commissions, have full Power and Authority to make, constitute, and ordain, Laws, Ordinances, and Decrees, and further, to do all and every thing mentioned in the Commission, according to the Purport, Effect, Words, and true Meaning, of the same; (2) and the same Laws and Ordinances, so made, to reform, repeal, and amend, and make new from Time to Time, as the Cases necessary shall require in that Behalf.

1 Mar. sess. 3 c. 11. 13 Eliz. c. 9.

The Ordinances of Commissioners upon those which refuse.

VIII. **Provided alway, and it is Enacted,** That if any Person or Persons, being assessed or taxed to any Lot or Charge for any Lands, Tenements, or Hereditaments, within the Limits of any Commission hereafter to be directed, do not pay the said Lot and Charge, according to the Ordinance and Assignment of the Commissioners having Power of the Execution of the said Commission, by reason whereof it shall happen, the said Commissioners having Power of the Execution of such Commission, for Lack of Payment of such Lot and Charge, to decree and ordain the same Lands, Tenements, and Hereditaments, from the Owner or Owners thereof, and their Heirs, and the Heirs of every of them, to any Person or Persons for Term of Years, Term of Life, in Fee Simple, or in Tail, for Payment of the same Lot and Charge, that then every such Decree and Ordinance so by them made and ingrossed in Parchment, and certified under their Seals into the King's Court of Chancery, with the King's Royal Assent had to the same, shall bind all and every Person and Persons, that at the making of the same Decree had any Interest in such Lands, Tenements, or Hereditaments, in Use, Possession, Reversion, or Remainder, their Heirs and Feoffees, and every of them, and not to be in any wise reformed, unless it be by Authority of Parliament hereafter to be summoned and holden within this Realm.

Extended to Copyhold Lands. 7 Ann. c. 10.

The Commissioners' Decree shall bind the King's and Men's Lands 3 Ed. 6. c. 8.

IX. **And also it is provided**, by Authority aforesaid, That the same Laws, Ordinances, and Decrees, to be made and ordained by the said Commissioners, or Six of them, by Authority of the said Commission, shall bind as well the Lands, Tenements, and Hereditaments, of the King our Sovereign Lord, as all and every other Person and

Persons, and their Heirs, for such their Interest as they shall fortune to have, or may have, in any Lands, Tenements, or Hereditaments, or other casual Profit, Advantage, or Commodity, whatsoever they be, whereunto the said Laws, Ordinances, and Decrees, shall in anywise extend, according to the true Purport, Meaning, and Intent, of the same Laws.

No man may sit being unsworn.

X. **And it is furthermore**, by the Authority aforesaid, **Established and Enacted**, That if any manner of Person or Persons, of what Estate or Degree soever he or they be of, that from henceforth do take upon him, or them, to sit by Virtue of any of the said Commissions, not being before sworn in Form as is aforesaid, and according to the Tenor of the Oath before specified; or if any Person so named and sworn, do sit as is aforesaid, not having Lands and Tenements, or other Hereditaments, in Fee Simple, Fee Tail, or for Term of Life, to the clear yearly value of Forty Marks, above all Charges, to his own Use, except he be resiant and free of any City, Borough, or Town Corporate, and have moveable substance of the clear Value of One Hundred Pounds, or else be learned in the Laws of this Realm, in and concerning the same, that is to say, admitted in one of the Four Principal Inns of Court for an utter Barrister, shall forfeit Forty Pounds, for every time that he shall attempt so to do;

What Land each Commissioner shall have. 13 El. c. 9. 25 H. 8. c 10.

(2) the one Half thereof to be to our Sovereign Lord the King, and the other Half thereof to the Use of him or them that will sue therefore, by Action of Debt, Bill, Plaint, or Information, in any of the King's Courts; in which Action or Suit no Wager of Law shall be admitted, nor any Essoign or Protection shall be allowed.

XI. And if any Action of Trespass, or other Suit, shall happen to be attempted, against any Person or Persons, for taking any Distress or any other Act doing by authority of the said Commission, or by Authority of any Laws or Ordinances made by Virtue of the said Commission, the Defendant or Defendants in any such Action shall and may make Avowry, Conusance, or Justification, for the taking of the same Distress; or other Act doing, touching the Premises, or of any of them, alleging in such Avowry, Conusance, or Justification, that the said Distress, Trespass, or other Act whereof the Plaintiff complaineth, was done by the Authority of the Commission of Sewers, for Lot or Tax assessed by the said Commission, or for such other Act or Cause as the said Defendant did, by Authority of the same Commission, and according to the Tenor, Purport, and Effect of this present Act, made the Three and Twentieth Year of the Reign of our Sovereign Lord, King *Henry* the Eighth, without any Expressing or Rehearsal of any other

Avowry or Justification of a Distress taken by Reason of the Commission of Sewers.

Co. pl. f. 293

Matter or Circumstance contained in this present Act, or any Commission, Laws, Statutes, or Ordinances, thereupon to be made: (²) whereupon the Plaintiff shall be admitted to reply, that the Defendant did take the said Distress, or did any other Act or Trespass supposed in his Declaration, of his own Wrong, without any such Cause alleged by the said Defendant, whereupon the Issue in every such Action shall be joined to be tried by Verdict of Twelve Men, and not otherwise, as is accustomed in other Personal Actions; (³) and upon the Trial of that Issue, the whole Matter to be given on both Parties in Evidence, according to the very Truth of the same.

Where the Defendant shall re-pay Damages with his Costs of Suit.

XII. **And**, after such Issue tried for the Defendant, or Nonsuit of the Plaintiff after appearance, the same Defendant to recover Treble Damages, by Reason of his wrongful Vexation in that Behalf, with his Costs also in that Part sustained, and that to be assessed by the same Jury, or Writ to enquire of Damages, as the Cause shall require.

The Wages and Fees of Commissioners, Clerks, Collectors, &c.

XIII. **And it is also Enacted**, That every of the said Commissioners shall have and receive Four Shillings for every Day that they shall take Pain in the Execution of this Commission of Sewers, and One Clerk by them to be assigned Two Shillings for every Day of the Rates, Taxes, Lots, and Wains, that shall be assessed or lost by the Authority of the said Commission, and to be levied and paid by their Discretions. (⁸) And that the said Commissioners, or Six of them, shall have Power and Authority to limit and assign of the same Rates, Taxes, Lots, and Wains, by their Discretions, such reasonable Sums of Money, to the said Clerk, for writing of Books, and Process, concerning the Premises, and to the Collectors, Expenditors, and such other as shall take Pain in the due Execution of the said Commission, as by the Discretions of the said Commissioners, or Six of them, shall be thought reasonable.

Commissions within the Liberty of the Duchy.

XIV. **Provided alway**, That whensoever, and as often as, such Commission as is afore limited, shall be made and directed, to any Person or Persons, for the Reformation and Amendment of or in any of the Premises specified in the said Commission within the Fees, Liberties, or Possessions, of the Duchy of *Lancaster*, that then such Commissioners as shall execute any such Commission, shall be always named and appointed by the Discretion of the Lord Chancellor, and Lord Treasurer of *England*, and the said Two Chief Justices of either Bench, and the Chancellor of the said Duchy for the Time being, or Three of them, whereof the said Lord Chancellor, and the Chancellor of the Duchy, to be Two; (²) and that, in every such Case, Two Commissions shall be awarded and made, according to the Tenor of the Commission above expressed, One thereof under the Great Seal of *England*, and the other under the Seal of the same Duchy, as before Time hath been accustomed; any Thing afore rehearsed in this Act to the Contrary hereof notwithstanding.

The Charge of the Commissions.

XV. **And it is further Enacted**, That the said Commissions, from Time to Time, as the Case shall require, shall be had and obtained, without any Money or other Charge to be paid, for the Seals or Writing of the same; unless it be to the King, Two Shillings and Six Pence, for the Seal of every Commission, as hath been accustomed, and for the Writing and Inrolling of any One Commission, Five Shillings, and not above.

A Commission of Sewers shall endure Three Years.

XVI. **And it is further Enacted**, That every Commission to be made by Authority of this Act, shall endure and continue for the Term of Three Years next after the Teste of the Commission; (2) nevertheless after any Commission made and delivered out of the King's Court of Chancery, the King's Highness shall always at his Pleasure, by his Writ of *Supersedeas* out of his said Court of Chancery, at any Time discharge as well every such Commission, as every Commissioner that shall be made or

altered by 13 El. c. 9. s. 1

A Commission or Commissioner discharged by *Supersedeas*.

named by Authority of this Act; (5) after which Discharge, the said Commissioner shall have no Power or Authority to proceed in the Execution of their Commission, nor in any Thing by Authority of this Act.

How long the Commissioners' Decree shall endure.

March 19, altered by 13 El. c. 9. s. 1.

XVII. **Provided always**, That such Laws, Acts, Decrees, and Ordinances, as shall happen to be made by the said Commissioners according to the Tenor of their Commission, or by Authority of this Act, shall stand good and effectual, and be put in due Execution so long Time as their Commission endureth, and no longer; except the said Laws and Ordinances be made and ingrossed in Parchment, and certified under the Seals of the said Commissioners into the King's Court of Chancery, and then the King's Royal Assent be had to the same; any Thing contained in this present Act to the Contrary hereof notwithstanding.

Commissions into a County Palatine.

XVIII. **Provided also**, That, whensoever, and as often, as such Commission as is afore limited, shall be made and directed to any Person or Persons for the Reformation and Amendment of, or in any of, the Premises specified in the said Commission within the Fees, Liberties, and Possessions, of the Principality of *Wales*, the County Palatine of *Chester*, or within the Fees, Liberties, and Possessions, of any other Place where there is Liberty and Jurisdiction of County Palatine, that in every such Case, Two Commissions shall be awarded, and made according to the Tenor of the Commission above expressed, one thereof under the Great Seal of *England*, and the other under the Usual Seal of the County Palatine, in Manner and Form as is above provided for the Duchy of *Lancaster;* any thing afore rehearsed in this present Act, to the contrary notwithstanding.

The King's Royal Assent shall be certified into the Chancery.

XIX. **And it is provided**, and also **Enacted**, That the Royal Assent limited, to be had unto the Laws and Ordinances to be made by the said Commissioners, as is abovesaid, shall be certified into the said Court of Chancery under the King's Privy Seal; (²) and that there shall not any Sum of Money be paid for the same Privy Seal, but for the Writing of the same Certificate, under the said Privy Seal, shall be paid to the Writer thereof Two Shillings, and not above, nor no other nor greater Sum, for any Thing touching or concerning the same Certificate under the same Privy Seal.

altered by 13 El. c. 9. s. 1.

Commissions in Wales and Counties Palatine.

XX. **Provided alway**, That the Chancellors and such others as shall have the Custody of the Seals of the said Principality of *Wales*, or the County Palatine of *Chester*, or within the

Regist. f. 127. made perpetual by 3 & 4 Ed. 6 c. 8. and explained by 3 Jac. 1 c. 14. & see farther 7 Ann. c. 10.

Fees, Liberties, and Possessions, of any other Place, where there is Liberty and Jurisdiction of County Palatine, upon reasonable Request, and upon the Sight of the Commission under the King's Great Seal of his Chancery, shall, without Delay, make out another Commission, under the Seal of the said County Palatine, according to the Tenor of the King's Commission, to them showed under his Great Seal; (*) and to those Commissioners as shall be named by the Lord Chancellor, Lord Treasurer, and the Two Chief Justices, or by Three of them, whereof the Lord Chancellor to be One, except it be within the Fees and Liberties of the Duchy of *Lancaster*, within which Fees and Liberties the Commissioners shall be named, and Commissions made as is afore ordained by this Act, any thing contained in the said Act, or in any Proviso thereunto added and annexed to the contrary thereof notwithstanding. (*) This Act to endure for Twenty Years.

EXTRACT OF

Statutes made at Westminster,

ANNO 3 & 4 EDWARD VI. A.D. 1548-9.

CAP. VIII.

An Act for the Continuance of the Statute of Sewers.

The Stat. 23 Hen. 8. c. 5. touching the Commission of Sewers made perpetual.

'**Whereas** in the Parliament holden 'at *Westminster*, by Prorogation, the 15 Day 'of *January*, in the 23rd Year of the most 'victorious Reign of our late Sovereign Lord, 'King *Henry* the Eighth, among other things, One 'general Act, concerning Commissions of Sewers, to be 'directed, into all Parts within this Realm, was enacted, 'and made to continue and endure for Twenty Years, then 'next following, as by the same Act more at large it doth 'and may appear: (2) and forasmuch as the same Act is 'thought good and beneficial for the Common-wealth of 'this Realm:' **Be it therefore Enacted and Ordained** by the King our Sovereign Lord, with the Assent of the Lords Spiritual and Temporal, and the Commons in this present Parliament assembled, and by the Authority of the same, That the said Act, and all Clauses, Articles, and Provisions, in the same contained, shall continue and endure in their Force and Strength, and to be observed and kept for ever, in such Manner and Form, as shall and may stand with the Sequel and Additions hereafter mentioned.

All Sums of Money rated by Force of the Commission of Sewers upon any of the King's Lands shall be leviable by Distress.

II. And be it further Enacted and Established, by the Authority aforesaid, that all Scots, Lots, and Sums of Money, hereafter to be rated and taxed, by Virtue of such Commission of Sewers, upon any of the Lands, Tenements, or Hereditaments, of our Sovereign Lord the King, his Heirs, or Successors, for any Manner of Thing or Things, concerning the Articles of the said Commission of Sewers, shall be gathered and levied by Distress, or otherwise, in like Manner and Form, as shall or may be done in the Lands, Tenements, and Hereditaments, of any other Person or Persons. (2) And that all Bills of Acquittance, signed with the Hand or Hands of such Collector or Receiver, as shall have the Collection thereof by the Appointment of the said Commissioners, or Six of them, shall be as well a sufficient Discharge to the Tenants, Farmers, and Occupiers, of the same Grounds, so to be charged for the same Sum, wherewith their Grounds shall be so charged; as also sufficient Warrant to all and every the Receivers, Auditors, and other whatsoever Officer or Officers, of our said Sovereign Lord the King, his Heirs and Successors, for the Allowance to such Tenant, Farmer, or Occupier, for the same; (3) adding moreover to this Act, by the Authority of this present

Parliament, that such and like Fees, and none other nor more, shall be at any Time paid or demanded, for any Commission or Commissions, or Writs of *Dedimus Potestatem*, hereafter to be sued out or obtained, under the Seal of the Duchy, but only such and like Fees as has been mentioned in the said former Act, to be paid in the Chancery, for Commissions and Writs of *Dedimus Potestatem* to be obtained from the same Court of Chancery: (4) adding moreover thereunto by the Authority abovesaid, that every Commission and Commissions, hereafter to be awarded for Sewers, shall continue and endure for Term of Five Years, next after the Teste of such Commission, unless the same Commission and Commissions shall be otherwise discharged within the said Time by *Supersedeas;* any Thing or Things mentioned or contained in the said former Act, contrary to the Additions before mentioned, or any of them, in any wise notwithstanding.

What Fees shall be paid for the Commission of Sewers sued out under the Seal of the Duchy.

How long the Commission of Sewers shall endure.

The Commissions to continue for Ten Years. 13 El. c. 9

EXTRACT OF

Statutes made at Westminster,

ANNO 13 ELIZABETH, A.D. 1570.

CAP IX.

An Act for the Commission of Sewers.

FORASMUCH as no Commission of Sewers, by the Estatutes heretofore made, may have Continuance above the Space of Five Years; (2) be it therefore Enacted by the Queen's Most Excellent Majesty, with the Assent of the Lords Spiritual and Temporal, and the Commons in this present Parliament assembled, and by the Authority of the same, That from henceforth all and every Commission and Commissions of Sewers, now standing in Force, or that hereafter shall be granted and made, shall stand and continue in Force for the Term of Ten Years next ensuing the Date of every such Commission, unless the same Commission or Commissions be, or hereafter shall be, repealed or determined, by Reason of any new Commission in that Behalf made, or by *Supersedeas*; (3) and that all such Laws, Ordinances, and Constitutions as be, or shall be, duly made by Force of any such Commission, according to the Tenor and Effect limited in any former Statute heretofore made touching Commission

23 H. 8. c. 5. 3 & 4. Ed. 6. c. 8.

Stat. 23. H. 8. c. 5.

A Commission of Sewers shall continue Ten Years.

The Orders of the Commissioners of Sewers shall be of Force without the Certificate of them or the Royal Assent or Commissions of Sewers, and being written in Parchment, indented, and under the Seals of the said Commissioners, or Six of them (whereof the One Part shall remain with the Clerk appointed, and to be appointed, for the Commission of Sewers for the Time being, and the other Part in such Place as the same Commissioners, or Six of them, shall order and appoint) shall, without any Certificate thereof to be made into the Court of Chancery, and without the Royal Assent to the same had, stand, and continue in full Force and Effect, notwithstanding any Determination of any such Commission by *Supersedeas*, until such Time, as the same Laws, Constitutions, and Ordinances shall be altered, repealed, or made void, by the Commissioners after to be assigned and appointed for Sewers, in those Parts where the same Laws, Ordinances, and Constitutions, were made, ordained, and constituted, or by Six of them.

The Commissioners of Sewers' Orders shall continue One Year, though the Commission do expire.

II. **And be it further Enacted**, by the Authority aforesaid, That at all Times, from and after the End and Expiration of the Term of Ten Years next ensuing the Date or Teste of any Commission of Sewers hereafter to be made; all such Laws, Ordinances, and Constitutions, as were made by Virtue of any such Commission, and written in Parchment, indented, and sealed, as is above mentioned, without Certificate thereof, or the Assent

Royal to the same had, as is aforesaid, shall, notwithstanding the Determination of any such Commission, by the Expiration of the Term of Ten Years, next ensuing the Date of any such Commission of Sewers, likewise continue in Force, for and by the Space of One whole Year then next ensuing;[e] and that the Justices of Peace, in the Shire and Shires, where the same Laws, Ordinances, and Constitutions, are to be executed within their several Commissions or Limits, or Six of them, whereof Two to be of the *Quorum*, shall have Power and Authority, by the Space of one whole Year, next after the Expiration of every such Commission, to execute the same Laws, Ordinances, and Constitutions, and every of them, as fully, and in as ample Manner and Form, as the Commissioners, or any of them, named and appointed, in every, or any Commission so expired, might or should have done, to all Intents and Purposes, as if the said Commission or Commissions had continued in Force.

The Justices of Peace may for One Year execute the Commission of Sewers unless a New Commission be granted.

III. **Provided always, and be it Nevertheless Enacted,** That if any New Commission of Sewers shall be made, within the said Year, that then, immediately from and after such Commission newly made and published, the Power of the said Justices of the Peace, and every of them, in any wise concerning the Execution of any such Laws, Ordinances, and Constitutions, of Sewers, shall utterly cease; any Thing or Things, in this Act, to the contrary expressed, in any wise notwithstanding.

A Farmer of Lands chargeable, shall not be a Commissioner within the same Precinct

IV. **And be it further Enacted,** That no Farmer or Farmers, for Term of Years, of any Manors, Lands, or Tenements, lying or being within the Precincts, or Limits, of any such Commission of Sewers, which be, or hereafter may be, ordered and chargeable, by any Laws, Ordinances, or Constitutions, made, or to be made, by Virtue of any such Commission, wherein he, or they, shall be named or appointed Commissioner, or Commissioners, not having Estate of Freehold, within the Realm of *England*, of or in Manors, Lands, or Tenements, of the Yearly Value of Forty Pounds, shall at any Time hereafter have Power to sit, or in any wise intermeddle with the Execution of such Commission or Commissions, during the Time he or they shall continue or be such Farmer or Farmers of any such Manors, Lands, or Tenements, and shall not have Estate of Freehold as is aforesaid;(2) but that every such Commission, as having Respect only to every such Person or Persons, for such and so long Time as he or they shall so be, and continue Farmer or Farmers of any such Manors, Lands, or Tenements, shall be deemed, and adjudged in Law, to be as void and of non-effect; any Thing in the same Commission, or any

Statute, or Law, heretofore made, to the contrary notwithstanding.

V. And be it further Enacted by the Authority aforesaid, That from henceforth the said Commissioners, nor any of them, shall not be compelled or compellable to make any Certificate or Return of the said Commissions, or any of them, or of any their Ordinances, Laws, or Doings, by the Authority of any the said Commissions, nor shall not have any Fine, Pain, or Amerciament, set upon them, or any of them, or any ways to be molested, in Body, Lands, or Goods, for that Cause.

There shall be no Certificate or Return of the Commission. 1 Lev. 288. 1 Vent. 66, 67.

VI. And yet nevertheless, to the Intent the Queen's Majesty, our Sovereign Lady, her Heirs, and Successors, may at all Times hereafter, be truly answered of all such Issues, Fines, and Amerciaments, as shall happen, grow, or be forfeited, by Virtue of any such Commission, or by the Execution thereof;(2) be it also Enacted, That the Clerk, and Clerks appointed, or hereafter to be appointed, for and in any such Commission and Commissions of Sewers, shall yearly, truly Estreat all the said Issues, Fines, Penalties, Forfeitures, and Amerciaments, that shall be due and answerable to her Highness, her Heirs and Successors; and the same Estreats shall yearly deliver into

The Fines and Amerciaments shall be estreated into the Exchequer. Altered by 3 & 4, W. 4. c. 99.

‘ other Statute made for Sewers, as the same should have ‘ been, if the Hurts, Noiances, and Inconveniencies, now ‘ by daily Experience felt and found in those Places, had ‘ been seen and considered of.’

V. 19. 410.
6 H. 6. c. 5.
8 H. 6. c. 3.
23 H. 8. c. 5.
25 H. 8. c. 10.
3 & 4 Ed. 6. c. 8.
1 Mar. sess. 3 c. 11.
13 Eliz. c. 9.
See further 7 Ann. c. 10.

II. **For** Reformation whereof, **be it Enacted** by our Sovereign Lord the King, and by the Lords Spiritual and Temporal, and Commons in this present Parliament assembled, and by the Authority of the same, that the Walls, Ditches, Banks, Gutters, Sewers, Gotes, Causeys, Bridges, Streams, and Watercourses, within the Limits of Two Miles, of and from the City of *London*, which Waters have their Course and Fall into the River of *Thames*, shall from henceforth be to all Intents, Constructions, and Purposes, as fully subject to the Commission of Sewers, and to all the Statutes made for Sewers, and to all Penalties in the same Statutes, and in every of them, contained, as if the same Places near to the said City of *London*, had been particularly named in the said Statute of Sewers, or that therein the Water had ebbed and flowed, and therein free Passage with Boats and Barges to the Sea had been heretofore used; any Thing in the said Statutes or elsewhere to the contrary in anywise notwithstanding.

EXTRACT OF

Statutes made at Westminster,

ANNO 2d WILLIAM & MARY. SESS. II. A. D. 1690.

CAP. VIII.

An Act for Paving and Cleansing the Streets in the Cities of London *and* Westminster, *and Suburbs and Liberties thereof, and Out-Parishes in the County of* Middlesex, *and in the Borough of* Southwark, *and other Places within the Weekly Bills of Mortality in the County of* Surrey, *and for regulating the Markets therein mentioned.*

SECT. XIV.

‘**And whereas** many new Sewers, Sinks, and Vaults, have been made in the Parishes within the City and Liberty of *Westminster*, and other the Parishes aforesaid, by the Commissioners appointed by the said recited Act, which, since the Expiration thereof, are much neglected and Noisome to the Inhabitants, because of some Doubt whether such new Sewers are within the Jurisdiction of the Laws of Sewers;’ be

New Sewers subject to the Commission of Sewers.
6 H. 6. c. 5.
8 H. 6. c. 3.
23 H. 8. c. 5.
25 H. 8. c. 10.
3 & 4 Ed. 6. c. 8.
1 M. ss. 3. c. 11.
13 Eliz. c. 9.
3 Jac. 1. c, 14.

it therefore **Enacted**, by the Authority aforesaid, That all new Sewers, at any Time since the Twelfth Year of the Reign of the said late King *Charles* the Second, made in any of the said Parishes, shall be henceforth subject to the Commission of Sewers, and to the Laws and Statutes made for Sewers, as fully to all Intents and Purposes, as if such Sewers, Sinks, and Vaults, had been expressly mentioned in the said Statutes of Sewers, to be under the Survey of the said Commissioners; and the Commissioners of Sewers for the Time being, within the Limits of their respective Commissions, shall have Power and Authority, by Virtue of this Act, to alter, amend, cleanse, and scour, any such new Sewers, Sinks, and Vaults, and to order and direct the making of any other new Vaults and Sewers, and to cut into any Drain or Sewer already made, and to alter and take away any Nuisances in the same, and to alter or take away any Cross Gutter or Channels, in all or any of the Streets and Lanes in the Parishes aforesaid.

EXTRACT OF

Statutes made at Westminster,

ANNO 7th ANNE. A.D. 1708.

CAP. X.

An Act for rendering more effectual the Laws concerning Commissions of Sewers.

Preamble, reciting the Laws in force concerning Commissions of Sewers.
6 H. 6. c. 5.
8 H. 6. c. 3.
4 H. 7. c. 1.
23 H. 8. c. 5.
25 H. 8. c. 10.
3 & 4. Ed. 6. c. 8.
1 Ma. ss. 3. c. 11
13 El. c. 9.
3 Jac. 1. c. 14.

'WHEREAS by the Laws now in 'force concerning Commissions of Sewers, it is 'provided, that, if any Person or Persons, being 'assessed or taxed to any Lot or Charge for 'any Lands, Tenements, or Hereditaments, 'within the Limits of any such Commission, do 'not pay the said Lot and Charge, according 'to the Order and Assignment of the Commis'sioners having Power of the Execution of the 'said Commission, that then the said Commissioners, for 'Lack of Payment of such Lot and Charge, may decree 'and ordain the said Lands and Tenements from the 'Owner or Owners thereof, and their Heirs, and the Heirs 'of every of them, to any Person or Persons, for Term of 'Years, Term of Life, Fee-simple, or Fee-tail, for Pay'ment of the same Lot and Charge, the said Decrees and 'Ordinances to be executed in such Manner, as by the 'said Laws now in force is directed and appointed: And

‘ it is thereby provided, That the same Decrees and Ordinances, shall bind all and every Person and Persons, that at the making of the same Decree had any Interest in such Lands, Tenements, and Hereditaments, in Use, Possession, Reversion, or Remainder, their Heirs and Feoffees, and every of them; and shall also bind as well the Lands, Tenements, and Hereditaments, of the King of *England*, as all and every other Person and Persons and their Heirs, and such their Interest, as they shall fortune to have in any Lands, Tenements, and Hereditaments, or other casual Profit, Advantage, or Commodity, whatsoever they be, whereunto the said Laws, Ordinances, and Decrees, shall in anywise extend, according to the true Purport, Meaning, and Intent, of the said Laws; but the said Laws of Sewers, now in force, have been found defective, in that sufficient Power and Authority is not thereby given to Commissioners of Sewers, to make Sale of Copyhold or Customary Lands within the Limits of their Commission for the Causes aforesaid;’ for Remedy whereof, Be it Enacted by the Queen's Most Excellent Majesty, by and with the Advice and Consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the Authority of the same, That, from and after the Five and Twentieth Day of *March*, in the Year of our Lord One Thousand Seven Hundred and Nine, it shall and may be lawful to and for the Commis-

After 25th March 1709, Commissioners of Sewers may, for Non-payment of any Lot assessed on Copyhold Lands, decree the same from the Owners, &c.

sioners authorised by Commission from Her Majesty, her Heirs and Successors, or any Six or more of them, to put in Execution the Laws now in force concerning Sewers, for Non-payment of any Lot or Charge assessed or charged upon any Copyhold or Customary Lands within the Limits of their Commission, and by the Power and Authority of the said Commission of Sewers to decree and ordain the said Copyhold or Customary Lands so charged from the Owner or Owners, and their Heirs, and the Heirs of every of them, to any Person or Persons, for such Estate and Interest therein, as the said Owner or Owners thereof, or any claiming in Remainder under them, at the Time of such Decree made, had in the same Copyhold Lands, Tenements, and Hereditaments; the said Decrees to be made and executed, as Decrees concerning Freehold Lands are by the said Laws now in force to be made and executed.

The said Decrees to be executed as Decrees concerning Freeholds.

II. **Provided always**, That all and every Person or Persons, to whom any such Sale of Copyhold or Customary Lands or Tenements shall be made, shall, before such Time as they or any of them shall enter or take any Profit of the same Lands or Tenements, agree and compound with the Lords of the Manors, of whom the same shall be holden, for such Fines or Incomes as heretofore hath been most usual and accustomed to be yielded or paid therefore; and that, upon every such

The Buyers of such Copyhold Lands to agree with the Lords of whom holden for the accustomed Fines, and the Lords to admit them Tenants.

Agreement or Composition, the said Lords for the time being, at the next Court to be holden at or for the said Manors, shall not only grant to such Vendee or Vendees upon request, the same Copyhold or Customary Lands or Tenements, by Copy of Court-Roll of the said Manors, for such Estate or Interest as to them shall be so decreed or sold, and reserving the ancient Rents, Customs, and Services, but also shall, in the same Court, admit them Tenants of the same Copyhold or Customary Lands, as other Copyholders of the same Manors have been wont to be admitted, and to receive their Fealty accordingly.

Six of the Commissioners may, by Warrant, impower any Person to levy the Assessments by Distress and Sale.

III. **And be it further Enacted and declared**, That it shall and may be lawful to and for the Commissioners of Sewers, or any Six or more of them, by Warrant under their Hands and Seals, to give Authority to any Person or Persons, to levy the Sums of Money by them, from Time to Time, to be assessed or taxed upon the Lands, Meadows, Marishes, or Grounds, liable or chargeable with any Sesses, Taxes, Impositions, or Charges, by Authority of their said Commission, by Distress and Sale of the Goods of such Person or Persons that shall not pay or refuse to pay the same; and the Overplus of the Money arising upon such Sale, after Deduction of the reasonable Charges of making such Distress and Sale, shall be restored to the Owner or Owners of the Goods so distrained.

The Overplus to be restored to Owner.

EXTRACT OF

Statutes made at Westminster,

ANNO 47th GEORGE III. SESS. I. A.D. 1807.

CAP. VII.

LOC. AND PERS.

An Act to enlarge the Powers and extend the Jurisdiction of the Commissioners of Sewers, for the City and Liberty of Westminster, and Part of the County of Middlesex.

Preamble, recites Act 3d James the First, c. 14.

'WHEREAS by an Act made and 'passed in the Third Year of the Reign of King '*James* the First, intituled, "An Act for the Ex-'planation of the Statute of Sewers," **It is Enacted**, 'That the Walls, Ditches, Banks, Gutters, Sewers, Gotes, 'Causeys, Bridges, Streams, and Watercourses, within the 'Limits of Two Miles of and from the City of *London*, 'which Waters have their Course and Fall into the River 'of *Thames*, should from thenceforth be, to all Intents, Con-'structions, and Purposes, as fully subject to the Commis-'sion of Sewers, and to all Penalties in the same Statutes 'and in every of them contained, as if the same Places near 'to the said City of *London* had been particularly named in 'the said Statute of Sewers, or that therein the Water 'had ebbed and flowed, and therein free Passage with 'Boats and Barges to the Sea had been theretofore used:

Act of 2d. K. William and Queen Mary, c. 8.

'**And whereas** by another Act passed in the 'Second Year of the Reign of *William* and *Mary*, 'late King and Queen of *England*, intituled, "An Act "for paving and cleansing the Streets in the Cities of "*London* and *Westminster*, and the Suburbs and Liberties thereof, and Out Parishes in the County of *Middlesex*, and in the Borough of *Southwark*, and other Places "within the Weekly Bills of Mortality in the County of "*Surrey*, and for regulating the Markets therein mentioned," **It is Enacted**, That all new Sewers at any 'Time since the Twelfth Year of the Reign of the late King '*Charles* the Second, made in any of the said Parishes, 'should be thenceforth subject to the Commission of Sewers, 'and to the Laws and Statutes made for Sewers, as fully to 'all Intents and Purposes as if such Sewers, Sinks, and 'Vaults, had been expressly mentioned in the said Statutes 'of Sewers to be under the Survey of the said Commissioners, and that the Commissioners of Sewers for the 'Time being, within the Limits of their respective Commissions, should have Power and Authority by Virtue of the 'said last-mentioned Act, to alter, amend, cleanse, and 'scour, any such new Sewers, Sinks, and Vaults, and to 'order and direct the making of any other new Vaults and 'Sewers, and to cut into any Drain or Sewer already made, 'and to alter and take away any Nuisances in the same, 'and to alter or take away any Cross Gutter or Channels, 'in all or any of the Streets and Lanes in the Parishes 'aforesaid. **And whereas** many Persons who reside at 'a greater Distance than Two Miles from the City of '*London*, have the Convenience of carrying off the Waters 'from their Lands and Houses by Means of divers Com'munications with the Great Sewers under the Management 'of the Commissioners for the City and Liberty of *West'minster*, and Part of the County of *Middlesex*. **And whereas** 'those Communications with the Great Sewers as aforesaid 'have caused great Expense to the said Commissioners, 'and considerable Hurt, Damage, and Inconvenience, to 'divers of His Majesty's Subjects, from the additional 'Quantity of Water which passes through them to the 'aforesaid Sewers, occasioned by the Increase of Build'ings out of the said Limits. **And whereas** divers 'Sewers, Streams, Drains, and Watercourses, which 'are situate or may be made beyond the Limits pre'scribed by the said recited Acts respectively, may 'require to be surveyed, corrected, and amended, by the 'said Commissioners, and Doubts having arisen whether 'the Sewers, Streams, Drains, and Watercourses, before 'mentioned, are under the Survey, Correction, and 'Amendment, of the said Commissioners for the City and 'Liberty of *Westminster* and Part of the County of '*Middlesex*, by Virtue of the several Statutes of Sewers: '**For** Reformation whereof, **be it Enacted** by the King's

Jurisdiction of the Commissioners extended to a certain Watercourse which divides Chelsea from Fulham.

Most Excellent Majesty, by and with the Advice and Consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the Authority of the same, That all the Walls, Ditches, Banks, Gutters, Sewers, Gotes, Causeys, Bridges, Streams, and Watercourses, West of the City of *London*, extending to and including a certain Watercourse, Part of which divides the Parish of *Chelsea* on the one side, from the Parish of *Fulham* on the other Side thereof, and including the several Parishes within the City and Liberty of *Westminster* and Precincts of the same West of and extending to *Temple Bar*, and also including the several Parishes of *Saint Giles in the Fields*, *Saint George Bloomsbury*, *Saint Pancras*, *Saint Mary-le-Bone*, *Saint John Hampstead*, such Part of the Parish of *Wilsden* as is drained by the Watercourses before mentioned, and the Parishes of *Paddington*, *Kensington*, and *Chelsea*, and all Sewers and Drains communicating with the same Watercourses, or with any of the ancient Sewers comprised within the Limits prescribed by the said Act of the Third Year of the Reign of King *James* the First, or with any of the Sewers mentioned or comprised in the said Act of the Second Year of the Reign of King *William* and Queen *Mary*, which Sewers and Waters have their Course and Fall into the River *Thames*, shall from henceforth be, to all Intents, Constructions, and Purposes, as fully subject to the Commission of Sewers for the

City and Liberty of *Westminster* and Part of the County of *Middlesex*, and to all the Statutes made for Sewers, and to all Penalties and Provisions in the same Statutes and in every of them contained; and that the same Commissioners and their Officers, and all Persons acting by their Authority, shall have the same Powers, Authorities, Remedies, Jurisdiction, Benefit of Pleading, Damages, and Costs, as if the said several Parishes within the said City and Liberty of *Westminster*, and the Precincts of the same, and the said several Parishes of *Saint Giles in the Fields*, *Saint George Bloomsbury*, *Saint Pancras*, *Saint Mary-le-Bone*, *Saint John Hampstead*, such Part of the Parish of *Wilsden* as aforesaid, and the Parishes of *Paddington*, *Kensington* and *Chelsea*, had been particularly named and described in the several Statutes of Sewers, or that therein the Water had ebbed and flowed, and therein free Passage with Boats and Barges to the Sea had been heretofore used; any Thing in the said Statutes or elsewhere to the contrary in anywise notwithstanding.

Power to widen, deepen, and alter, the present Sewers, and to make new ones, &c.

And whereas by the increase of Buildings and various Improvements made and intended to be made within the Limits last described, it may become necessary to make new Drains, Sewers, and Watercourses, and to alter and divert the Course of some of the ancient Sewers: **Be it therefore Enacted by the Authority aforesaid,** That the said Commissioners of Sewers for the Time being, or such Number of them as are authorized to act by virtue of the Commission of Sewers, shall have Power and Authority by Virtue of this Act, within the Limits of their said Commission before described, from Time to Time as they shall see occasion, to widen, deepen, embank, alter, amend, cleanse, and scour, any Sinks, Vaults, Sewers, Drains, and Watercourses, and to remove and take away, or cause to be removed and taken away, Nuisances in the same, and to alter and divert the Course of the Water in any of the Streets, Lanes, and Public Ways, and also to order and direct the making of any new Vaults, Sewers, Drains, and Watercourses, in all or any of the Streets, Lanes, and Public Ways, made or to be made within the Limits last before described; and such new Vaults, Sewers, Drains, and Watercourses, shall be subject to the Controul, Order, and Direction, of the Commissioners of Sewers, their Surveyors and Officers, and to the Laws and Statutes, made for Sewers, as fully to all Intents and Purposes as if such Vaults, Sewers, Drains, and Watercourses, had been expressly mentioned in the said Statutes of Sewers, to be under the Survey and Authority of the said Commissioners.

No Sewer to be hereafter made or constructed without Notice being sent to the Commissioners of Sewers.

'And whereas great Evils have arisen, and 'considerable Expense hath been and is still 'likely to be occasioned to the said Commission, 'by the improper Construction of new Sewers to 'carry off the Water and Soil from Lands and

'Buildings into the Sewers under the Management of the 'said Commissioners, and from bad and improper Materials 'being used therein, previously to the same new Sewers 'being taken under the Management of the said Commis'sioners, whereby the same are liable soon to fall into Decay, 'and become a Nuisance to the Inhabitants and other His 'Majesty's Subjects;' Be it therefore Enacted by the Authority aforesaid, That, previous to the making of any new Sewer, in any Street, Lane, or Public Way, or in any Part intended to be or become a Street, Lane, or Public Way, within the Limits of the said Commission, or which shall be intended to carry or drain off Water, from any House, Building, Yard, or Ground, into any Sewer under the Management or within the Jurisdiction of the said Commission of Sewers, Notice in Writing shall be given to the Commissioners of Sewers, for the Limits aforesaid, for the Time being, or to the Clerk of the said Commissioners, at their Office; and that such new Sewer or or Sewers shall be constructed and made in such Manner and Form, and with such Materials and Workmanship, under the Survey and Controul, and according to the Direction, of the said Commissioners of Sewers, their Surveyor, or other Person by them duly authorized, and not otherwise; or, in Default thereof, the said Commissioners or any Six of them, may cause such Sewer to be prostrated, demolished, put down, corrected, amended, reformed, or rebuilt, as the Case may require, after their Wisdom and

Discretion, and shall and may cause the Expense thereof to be levied by Distress and Sale of the Goods and Chattels of the Person or Persons so making or causing to be made such Sewer contrary to this Statute, by Warrant under the Hands and Seals of the said Commissioners or any Six of them, or may otherwise punish such Offender or Offenders by Fines, Amerciaments, Pains, or other like Means, as are provided by any of the Statutes of Sewers in case of Non-payment of Taxes or Assessments, taxed or assessed under and by Virtue of such Statutes or any of them.

Public Act. } **And be it further Enacted,** That this Act shall be deemed and taken to be a Public Act, and shall be judicially taken Notice of as such by all Judges, Justices, and others, without being specially pleaded.

EXTRACT OF

Statutes made at Westminster,

ANNO 52, GEORGE III. A.D. 1812.

LOC. AND PERS.

CAP. XLVIII.

An Act for empowering the Commissioners of Sewers for the City and Liberty of Westminster, *and Part of the County of* Middlesex, *to purchase a Messuage and Premises, for holding their Meetings; and for enlarging the Powers of the said Commissioners.*

23 Hen. VIII. ch. 5.

‘ **Whereas** in the Twenty-third year
‘ of the Reign of His Majesty, King *Henry* the Eighth,
‘ one general Act concerning Commissioners of Sewers,
‘ intituled, “ The Bill of Sewers, with a new Proviso,
‘ &c.” to be directed into all Parts within His said Majesty’s
‘ Realm, was enacted, and made to continue and endure for
‘ Twenty Years then next following; and the said Act and
‘ all the Clauses, Articles, and Provisions, in the same, were,
‘ by an Act of the Third and Fourth Years of the Reign of

3 & 4 Ed. 6. ch. 8. ‘ His Majesty King *Edward* the Sixth, intituled “ An Act for the continuance of the Statute of ‘ Sewers,” made perpetual, subject to certain new Regula‘tions expressed and contained in the last-mentioned Act:

13 Elizabeth, ch. 9. ‘ **And whereas**, by an Act passed in the Thir‘teenth Year of the Reign of Queen *Elizabeth*, ‘ intituled, “ An Act for the Commission of Sewers;” and 3 James 1. ch. 14. ‘ an Act passed in the Third Year of the Reign ‘ of King *James* the First, intituled, “ An Act ‘ for the “ Explanation of the Statute of Sewers;” and an 2 W. & Mary, Sess. 2, ch. 8. ‘ Act passed in the Second Year of the Reign of ‘ King *William* and Queen *Mary*, intituled, “ An “ Act for paving and cleansing the Streets in the Cities of “ *London* and *Westminster*, and Suburbs and Liberties “ thereof, and Out Parishes in the County of *Middlesex*, “ and in the Borough of *Southwark*, and other Places within “ the Weekly Bills of Mortality in the County of *Surrey*, “ and for regulating the Markets therein mentioned;” and ‘ an Act passed in the Seventh Year of the Reign of 7 Anne, ch. 10. ‘ Queen *Anne*, intituled, “ An Act for rendering “ more effectual the Laws concerning Commis“sions of Sewers;” and an Act passed in the Forty- 47 Geo. III. Sess. 1. ch. 7. ‘ seventh Year of the Reign of His present Ma‘jesty, King *George* the Third, intituled, “ An “ Act to enlarge the Powers and extend the Jurisdiction of “ the Commissioners of Sewers for the City and Liberty “ of *Westminster* and Part of the County of *Middlesex*;”

'the Provisoes and Provisions contained in the said Acts of 'the Twenty-third Year of the Reign of His Majesty, King '*Henry* the Eighth, and the Third and Fourth Years of the 'Reign of His Majesty, King *Edward* the Sixth, have been 'varied, altered, enlarged, and extended: **And** **Whereas**, by His Majesty's Letters Patent, 'one under the Great Seal of the United Kingdom of 'Great Britain and Ireland, bearing Date the Twenty-'ninth Day of March, in the Forty-sixth Year of the 'Reign of His present Majesty, and the other under the 'Seal of the Duchy of Lancaster, bearing Date the Twen-'ty-eighth Day of April, in the said Forty-sixth Year of 'the Reign of His said present Majesty, the Right Honour-'able *Thomas* Lord *Erskine*, then Lord High Chancellor 'of that Part of Great Britain and Ireland called Great 'Britain, *Charles*, Duke of *Norfolk*, *George*, Duke of '*Marlborough*, *Edward*, Lord *Ellenborough*, Sir *William* '*Grant*, Knight, Sir *James Mansfield*, Knight, and others 'therein named, have been appointed Commissioners of 'Sewers for the City and Liberty of *Westminster*, and 'Part of the County of *Middlesex*. **And** **Whereas**, on 'Account of the great Increase of Building, and the ex-'tensive Projects for Building now in Contemplation, or 'carrying into Effect, within the City and Liberty of '*Westminster*, and the Part of the County of *Middlesex* 'subject to the said Commissions, it is rendered necessary 'and expedient that the said Commissioners should be

Letters Patent, 29 Mar. & 28 April, 46 Geo. 3.

'enabled to purchase a Messuage and Premises for holding their Meetings, and for keeping the Records, Books, and Papers, of the said Commission, or for any other Concern relating thereto; and that the Powers of the said Commissioners should be enlarged.'

May it therefore please Your MAJESTY,

That it may be Enacted; And be it Enacted by the KING'S Most Excellent MAJESTY, by and with the Advice and Consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the Authority of the same, That it shall be lawful for the Commissioners of Sewers for the Time being for the Limits aforesaid, and they, or any Six or more of them, are hereby authorized and empowered, to sell a certain Messuage and Premises, with the Appurtenances, where the Business of the said Commissioners has been carried on, situate in *Carlisle-street*, *Soho-square*, in the Parish of *Saint Ann*, within the Liberty of *Westminster*, in the County of *Middlesex*, for all such Estate, Term, and Interest, therein, as the said Commissioners have, and the Goods, Furniture, and Fixtures, therein, belonging to the said Commissioners, and to apply the Produce thereof in or towards the Payment of the Purchase Money for the Premises hereinafter mentioned, or for or towards any of the Purposes authorized to be done and executed by the said Commis-

Commissioners may treat with Owners for purchase of a Messuage, &c. in Greek-street, Soho.

sioners under or by Virtue of the said Commissions; and also to treat and agree with all and every the Owner or Owners, Proprietor or Proprietors, Trustee or Trustees, or other Person or Persons whomsoever interested therein, for the Purchase of the Fee Simple and Inheritance of a certain Messuage or Tenement, situate the Corner House on the South Side of *Soho-square*, and at the North End on the East Side of *Greek-street*, in the Parish of *Saint Ann*, within the Liberty of *Westminster*, in the said County of *Middlesex*, with the Coach-houses, Stables, Out-buildings, and Appurtenances, thereto belonging, late the property of *Thomas Slack*, Esquire, deceased, and now in the Occupation of the said Commissioners, and more particularly mentioned in the Schedule to this Act annexed, for the Purpose of holding their Meetings, and for keeping the Records, Books, Writings, and Papers, of the said Commissions, or for any other Concern relating thereto; and it shall be lawful for the said Commissioners to hold such Messuage and Premises so to be purchased, without incurring or being subject to any of the Penalties or Forfeitures of the Statutes of Mortmain, or of any other Law or Statute whatsoever to the contrary thereof in any wise notwithstanding; **Provided always** That no greater or larger Sum shall be given for the Purchase of the said Messuage and Premises, than the Sum of Five Thousand Pounds.

Proviso.

Power to borrow Money

II. And be it further Enacted, That it shall be lawful for the said Commissioners from Time to Time to borrow and take up at Interest such Sum or Sums of Money, not exceeding in the whole the Sum of Five Thousand Five Hundred Pounds on the Credit of the Rates, Taxes, Lots, and Wains, to be made, levied, set, and collected, by Virtue of the said recited Acts, or some or One of them; and by Writing under their Hands and Seals, or of any Six or more of them, to assign all or any Part of the said Rates, Taxes, Lots, and Wains, to such Person or Persons as shall lend or advance any Money thereon, or to his, her, or their, Trustee or Trustees, as a Security for the Principal Money to be advanced, with lawful Interest for the same; and the Charges and Expenses of such Assignment (to be made as hereinafter mentioned) shall be from Time to Time defrayed by the said Commissioners out of the Money so to be borrowed; and every such Assignment shall be in the Words or to the Effect following (that is to say);

Form of Assignment.

"We, being of "the Commissioners of Sewers for the "City and Liberty of *Westminster*, and Part of the "County of *Middlesex*, acting in pursuance of an "Act passed in the Fifty-second Year of the "Reign of King George the Third, intituled [*here* "*set forth the Title of this Act*] in Consideration

" of the Sum of advanced and
" lent by of
" in the County
" of on the Credit
" and for the Purposes of the said Act, DO
" hereby grant and assign unto the said
" [*or*, to his Trustee or Trustees, as
" the case may be] his [*or*, her] Executors, Administrators, and Assigns, such Proportion of the
" Rates, Taxes, Lots, and Wains, to be raised,
" levied, set, and collected, by Virtue of the said
" recited Acts, or some or one of them, as the said
" Sum of doth or shall
" bear to the whole Sum which may at any Time
" be borrowed or become due and owing, or be
" charged upon the Credit of the said Rates,
" Taxes, Lots, and Wains; to be had and holden
" from this Day of
" until the said Sum of
" with Interest after the Rate of per
" Centum per Annum for the same, shall be fully
" paid and satisfied. In witness whereof, We the
" said Commissioners have hereunto set our Hands
" and Seals, the Day of
" in the Year of our Lord

And every such Security shall be good, valid, and effectual, in the Law, and shall entitle the Person or Persons to whom the same shall be made, his, her, or their, Executors, Administrators, and Assigns, to the Payment thereof, according to the true Intent and Meaning of this Act.

Commissioners may raise Money by Annuities.

III. And be it further Enacted, That in case the said Commissioners shall think it advisable to raise all or any part of the Money for the Purposes aforesaid, by granting Annuities for Lives, instead of Assignments as aforesaid, then and in such Case it shall be lawful for the said Commissioners, and they are hereby authorized and empowered so to do, and by Writing under their Hands and Seals, or of any Six or more of them, to grant an Annuity or Annuities to any Person or Persons who shall contribute, advance, and pay into the Hands of the Treasurer or Treasurers of the said Commissioners, any Sum or Sums of Money for the absolute Purchase of any Annuity or Annuities to be paid and payable during the natural Life or natural Lives of such Contributor or Contributors, and the Life of the Survivor, or the natural Life of such Person, or the natural Lives of such Persons, and the Life of the Survivor, as shall be nominated by or on the Behalf of such Contributor at the time of the Payment of his or her Contribution or Purchase-money; so as that no such Annuity do exceed the Rate of Ten Pounds per Centum per Annum upon a single

Life, or the Lives of such Persons, and the Life of the Survivor; and the Expense of every such Annuity shall be paid by the said Commissioners out of the Monies so contributed; **And** the Grant of every such Annuity shall be in the Words or to the Effect following:

Form of Grant of Annuity.

"**We**, being of the
"Commissioners of Sewers for the City
"and Liberty of *Westminster*, and Part of the
"County of *Middlesex*, acting in pursuance of an
"Act passed in the Fifty-second Year of the
"Reign of King *George* the Third, intituled,
"[*here set forth the Title of this Act*] in consider-
"ation of the Sum paid by
" to the Treasurer
"to the said Commissioners, DO hereby grant unto
"the said an Annuity or yearly
"Sum of to be paid out of the
"Rates, Taxes, Lots, and Wains, to be raised,
"levied, set, and collected, by Virtue of the said
"recited Acts, or some or one of them; which
"Annuity or yearly Sum of
"shall be paid to the said or his
"or her Assigns, during the Term of his or her
"natural Life [*or, as the Case may be*] to the
"said his or her Executors,
"Administrators, or Assigns, during the natural

"Life of or during the natural
"Lives of and
"and the Life of the Survivor of them, on the
" Day of the
"Day of the Day of
" and the Day of
" in every Year, during the natural
"Life or Lives of him, her, or them, the said
" at the the first
" Payment thereof, to be made on
"the Day of next
"ensuing the Date hereof. In Witness whereof,
"We the said Commissioners have hereunto set
"our Hands and Seals, the Day
"of in the Year

And every such Grant shall be good, valid, and effectual, in the Law, without any Enrolment or Registry of the Memorial thereof in the High Court of Chancery, or elsewhere, except as hereinafter mentioned, any Law or Statute to the contrary thereof in anywise notwithstanding: And every Annuity so to be granted as aforesaid, shall be, and is hereby, charged upon, and shall be payable and paid by the Treasurer to the said Commissioners, out of the said Rates, Taxes, Lots, and Wains, respectively, according to the Grant of such Annuity; and that the said

Purchase-money may be paid out of Monies in Hand. Also Expenses of Repair and Fittings, and usual Expenses for carry- Commissions into Effect.

Commissioners shall and may, if they think it most advisable, by and out of any Monies in the Hands of the said Commissioners, or their Treasurer, pay the said Purchase-money of Five Thousand Pounds, and the Costs and Charges of repairing and fitting up the Premises, as well as all other usual and reasonable Expenses that may be incurred by the Commissioners, in carrying the said Commissions into Effect.

Power of transferring Assignments and Annuities.

IV. **And be it further Enacted,** That it shall be lawful for the Persons entitled to any of the Securities for the Money to be borrowed on legal Interest as aforesaid, or to be raised by granting of Annuities as aforesaid, and their respective Executors, Administrators, or Assigns, [*as the Case may be*] at any Time, by Writing under their Hands and Seals, to transfer such Securities to any Person or Persons whomsoever; and every such Transfer may be in the Words or to the Effect following:

"I, *A. B.* being entitled to the sum of
" or an Annuity of secured to
" and his Assigns [*as the Case may be*] by Virtue
" of an Assignment [or, Grant of an Annuity]
" bearing date the day of
" under the Hands and Seals of the Commis-

"sioners of Sewers for the City and Liberty of
"*Westminster*, and Part of the County of *Mid-*
"*dlesex*, acting in the Execution of an Act passed
"in the Fifty-second Year of the Reign of King
"*George* the Third, intituled, [*here set forth the*
"*Title of this Act*] on the Credit of the Rates,
"Taxes, Lots, and Wains, charged and made
"chargeable by the said Act; DO hereby transfer
"all my Right and Interest in and to the same Sum
"[or Annuity, and all Interest and other Money
"now due and arising thereon] unto
"   his or her Executors, Administrators,
"and Assigns. Dated the
"Day of

And a Copy of every such Security or Assignment, and of every Grant of Annuity which shall be made in pursuance of this Act, and an Extract or Memorial of every Transfer thereof respectively, shall be entered in a Book to be kept for that Purpose by the Clerk to the said Commissioners; which Extract or Memorial shall specify and contain the Date, Names of the Parties, and Sums of Money thereby transferred; to which Book any Person interested shall at all seasonable Times have access, and shall have free Liberty to inspect the same, without Fee or Reward; and for the entering of every such Transfer, the Clerk to the said Commissioners shall be paid by the Person to whom such Transfer shall be made, the Sum of Two Shillings and Sixpence and no more; and every such Transfer, after Entry thereof as aforesaid, shall entitle the Person to whom the Transfer shall be made, and his or her Executors, Administrators, and Assigns, to the Benefit of the Security thereby transferred, without any Registry or Enrolment thereof.

Provision for payment of the Creditors by Ballot.

V. **And**, in order that no Preference may be given to any of the Persons who shall have advanced and lent Money on the Credit of the said Rates, Taxes, Lots, or Wains; **be it further Enacted**, that the said Commissioners (if there shall be more Creditors than one) shall cause the Number or Numbers of all Assignments or Securities granted, in case more than the Sum of One Hundred Pounds shall be lent and advanced upon any such Assignment or Security as aforesaid, and then in force for securing the Principal Monies lent and advanced on the Credit of the said Rates, Taxes, Lots, or Wains, of which Part shall be then intended to be paid off, to be written upon distinct Pieces of Paper of an equal Size, each Piece of Paper to contain only One Number in respect of every One Hundred Pounds so borrowed as aforesaid, and all such Papers shall be rolled up in the same Form, as near as may be, and be put into a Box or Wheel, and the Number or Numbers of the said

Assignments or Securities shall be drawn separately out of the said Box or Wheel, by the Clerk to the said Commissioners; and after every such Ballot, the said Commissioners shall cause Notice, signed by their Clerk, to be given to or left at the last or usual Place of Abode of the Person or Persons who shall be entitled to the Money to be paid off, either in full or part Payment of their respective Assignments or Securities as aforesaid, pursuant to such Ballot; and where there is only one Creditor, to give Six Calendar Months' Notice to such Creditor, of the Intention of the said Commissioners to pay him or her as aforesaid, and every such Notice shall express the Sum to be paid off, together with the Interest due thereon, and that the same shall be paid on a Day and at a Place to be specified in such Notice, such Day not being sooner than Six Calendar Months after the Day of giving or leaving such Notices as aforesaid; and the Interest of the Principal Money to be so paid off, shall, from and after the Day so specified, cease and be no longer paid or payable, unless such Money shall be demanded pursuant to such Notice, and not paid; but the Principal Money in respect whereof such Notice shall be given, and also the Interest thereof to the Day so specified, shall nevertheless be payable on Demand; but nothing herein contained shall extend, or be construed to extend, to require the said Commissioners to pay off and discharge any Monies lent on the Credit of the said Rates, Taxes, Lots, and Wains, by Way of

Annuity, until all other the Creditors on the said Rates, Taxes, Lots, and Wains, shall be paid off and discharged, and the several Parties so lending Money by Way of Annuity shall agree to accept the Sum or Sums of Money offered by the said Commissioners, for the Re-purchase of such his, her, or their, Annuity or Annuities.

Power to borrow Money at lower Interest, to discharge securities at higher Rate.

Provided always, and be it further Enacted, That in case the said Commissioners can at any time borrow or take up any Sum or Sums of Money at a lower Rate of Interest than the Assignments or Securities which shall be then in force shall bear, it shall be lawful for the said Commissioners from Time to Time to charge the said Rates, Taxes, Lots, and Wains, in manner aforesaid, with such Sum or Sums of Money as they shall think proper, and the Interest thereof at such low Rate as aforesaid: and to pay off and discharge the Assignments or Securities bearing a higher Rate of Interest, according to the Directions and Regulations therein prescribed for paying off Assignments or Securities.

Recital of Difficulties in laying an equal Rate.

And whereas great Difficulty has arisen to the Commissioners of Sewers for the Limits aforesaid, in laying an equal Rate from Time to Time upon the several Inhabitants within the Limits of the said Commissions, occasioned by their not being authorised, under any of the Statutes now in force concerning Sewers, to call for and inspect the Poor's Rates of the several Parishes within the Limits aforesaid; **Be it therefore further Enacted,** That it shall be lawful for the said Commissioners of Sewers for the Limits aforesaid, from Time to Time as the said Commissioners shall see Occasion, by an Order in Writing, to direct the Clerk for the Time being of the said Commissioners, or any other Person on their Behalf, to inspect and take a Copy of the last Rate or Assessment for the Relief of the Poor of any Parish or Parishes within the Jurisdiction of the said Commissioners of Sewers, and on production of such Order by the Clerk of the said Commissioners, or other Person as aforesaid, to the Vestry Clerk or other Person entrusted with the Custody of the several Rates aforesaid, such Vestry Clerk, or other Person entrusted with the Custody of the said Rates of every such Parish, shall produce the same forthwith to the said Clerk of the said Commissioners, and permit him to inspect and take a Copy thereof from Time to Time; or otherwise shall furnish, with all convenient speed, to the Clerk of the said Commissioners for the Time being, a true Copy of the Book of Rates of such Parish or Parishes as aforesaid, on being paid for the same such Fees as are directed by an Act of the Seventeenth Year of King George the Second,

Commissioners authorized by their Clerk to inspect Books of Rates of all Parishes within their Limits.

Vestry Clerk &c. to suffer Rate Books to be inspected and copied or to furnish Copies.

intituled, "An Act to oblige Overseers of the Poor to give public Notice of Rates made for the Relief of the Poor, and to produce the same," in order to enable the said Commissioners of Sewers to lay an equal Rate or Assessment on the several Inhabitants within the Limits of the said Commissions, or any Portion thereof.

Distress not unlawful for want of Form.

And be it further Enacted, That when any Distress shall be made for any Sum of Money to be levied by Virtue of the said recited Acts, or this Act, or any of them, the Distress itself shall not be deemed unlawful, nor shall the Party or Parties making the same be considered a Trespasser or Trespassers on account of any Default or want of Form in the Information, Summons, Conviction, Warrant of Distress, or in any other Proceeding relating thereto, nor shall the said Party or Parties distraining, be considered a Trespasser or Trespassers *ab initio*, on account of any Irregularity which shall afterwards happen to be committed by the Party or Parties so distraining; but the Person or Persons aggrieved by such Irregularity shall and may recover full Satisfaction for the special Damage which he, she, or they, shall have sustained thereby, with usual Costs, and no more, in an Action of Trespass, or on the Case.

Plaintiff not to recover without No-

And be it further Enacted, That no Plaintiff or Plaintiffs shall recover in any Action tice, or after Tender of Amends

to be commenced against any Person for any Thing done in pursuance of the said recited Acts, or this Act, or any of them, unless Notice in Writing shall have been given to the Defendant or Defendants, Twenty-eight Days before such Action shall be commenced, of such intended Action, signed by the Attorney for the Plaintiff or Plaintiffs, specifying the Cause of such Action; nor shall the Plaintiff recover in any such Action, if Tender of sufficient Amends shall have been made to him, her, or them, or his, her, or their, Attorney, by or on the behalf of the Defendant or Defendants, before such Action brought; and in Case no such Tender shall have been made, it shall be lawful for the Defendant or Defendants, in any such Action, by Leave of the Court, after such Action shall have been brought, at any Time before Issue joined, to pay into Court such Sum of Money as he, she, or they, shall think fit; whereupon such Proceedings, Order, and Judgment, shall be made and given, in and by such Court, as in other Actions where the Defendant is allowed to pay Money into Court.

Limitation of Actions.

Provided always, and be it further Enacted, That no Action or Suit shall be commenced against any Person or Persons for any Thing done in pursuance of the said recited Acts, or this Act, or any of them, after the Expiration of Six Calendar Months next after the Fact committed; and every such Action shall be brought and tried in the County of *Middlesex*, and not elsewhere; and if any such Action or Suit shall be brought before Twenty-eight days' Notice shall have been given, or after sufficient satisfaction made or tendered as aforesaid, or after the time limited for bringing the same as aforesaid, then, and in every such Case, the Jury shall find a Verdict for the Defendant or Defendants; and if, upon such Verdict, the Plaintiff or Plaintiffs shall be non-suited or discontinue his, her, or their, Action or Suit after the Defendant or Defendants shall have appeared, or if upon Demurrer, Judgment shall be given against the Plaintiff or Plaintiffs, then, and in every such Case, the Defendant or Defendants shall recover double Costs, and shall have such Remedy for Recovery of the same, as any Defendant hath for Costs of Suit in other Cases by Law.

Former Acts to remain in force.

And be it further Enacted, That the said recited Acts, and all the Powers, Authorities, Provisions, Clauses, Matters, and Things, therein contained, shall remain and be in force as fully and effectually, in all Respects, and to all Intents and Purposes, as if the same were repeated and re-enacted in this present Act, except only as the same are hereby varied or altered.

Costs and Charges of Act.

And be it further Enacted, That all Costs, Charges, and Expenses, of obtaining and passing this Act, and of carrying the same into execution (except as herein otherwise provided for) shall be paid out of the Rates, Taxes, Lots, and Wains, to be levied, collected, or set, by Virtue of the said recited Acts, or some or one of them.

Public Act. } **And be it further Enacted,** That this Act shall be deemed and taken to be a Public Act, and shall be judicially taken Notice of as such by all Judges, Justices, and Others, without being specially pleaded.

THE SCHEDULES

TO WHICH

This Act refers.

SO FAR AS RELATES TO THE PREMISES

IN

GREEK STREET, SOHO.

A CAPITAL MESSUAGE or TENEMENT, with the Stables, Coach-houses, Out-buildings, and Appurtenances, situate on the South Side of *Soho-square*, and at the North End, and on the East Side of *Greek-street*, in the Parish of *Saint Ann*, in the Liberty of *Westminster*, and County of *Middlesex*.

SO FAR AS RELATES TO THE PREMISES

IN

CARLISLE STREET, SOHO.

A MESSUAGE or TENEMENT, with the Appurtenances, situate on the North Side of *Carlisle-street*, in the Parish of *Saint Ann*, *Westminster*, aforesaid, lately in the Occupation of the said Commissioners of Sewers.

EXTRACT OF

Statutes made at Westminster,

ANNO 4 & 5 WILLIAM IV. A. D. 1834.

CAP. XCVI.

An Act to enable the Commissioners of Sewers for the City and Liberty of Westminster, *and Part of the County of* Middlesex, *to make a new Sewer at* Bayswater, *in the County of* Middlesex.

Letters Patent, dated 27th August 1 W. 4, and and 18th Sept. 1 W. 4.

'WHEREAS, by His Majesty's 'Letters Patent, one under the Great Seal of 'the United Kingdom of *Great Britain* and '*Ireland*, bearing Date the Twenty-Seventh 'Day of *August*, in the First Year of His Majesty, King '*William* the Fourth, and the other under the Seal of the 'Duchy of *Lancaster*, bearing Date the Eighteenth Day of '*September* in the said First Year of the Reign of His said 'Majesty King *William* the Fourth, the Most Reverend 'Father in God, *William* Archbishop of *Canterbury*, *John* '*Singleton* Lord *Lyndhurst*, then Lord High Chancellor of '*Great Britain*, *Henry Charles* Duke of *Beaufort*, and 'others therein named, have been appointed Commissioners 'of Sewers for the City and Liberty of *Westminster* and Part 'of the County of *Middlesex;* And whereas by virtue of an 'Act made and passed in the Forty-seventh Year of the 'reign of King *George* the Third, intituled *An Act to* '*enlarge the Powers and extend the Jurisdiction* '*of the Commissioners of Sewers for the City* '*and Liberty of* Westminster *and Part of the County of* 'Middlesex, the Jurisdiction of the said Commissioners 'was extended to and over the Walls, Ditches, Banks, 'Gutters, Sewers, Gotes, Causeys, Bridges, Streams, and 'Watercourses, of the City of *London* as therein mentioned, 'extending to and including amongst others the Parishes 'of *Saint John Hampstead, Paddington,* and such Part of 'the Parish of *Willesden* as is drained by the Watercourses 'therein mentioned: And whereas by reason of the Increase 'of Buildings, and various Improvements made and intended 'to be made in the Parts of the Parishes of *Saint Mary* '*Paddington, Saint Mary-le-bone, Saint John Hampstead,* 'and *Willesden,* lying on the North Side of the Road 'leading from *Oxford-street* to *Uxbridge,* called the '*Uxbridge Road,* it is expedient that the Drainage thereof 'should be altered, enlarged, and improved, and that the 'Soil Drainage of the *Bayswater* or *Westbourn Brook* 'should be diverted from the *Serpentine* River, and that for 'such purposes the aforesaid Commissioners of Sewers 'should be authorized to make such Wear or Tumbling 'Bay and a Tunnel Sewer as is herein-after mentioned, and 'should have such Powers as are hereinafter contained for

47 Geo. 3. c. 7.

'raising one Moiety of the Monies necessary to defray 'the expenses of constructing the same; and it is reasonable that the other Moiety thereof should be defrayed out 'of the Land Revenues of the Crown, in consideration of 'the Advantages which the Property of the Crown, will 'derive by the Diversion of the Soil Drainage from 'the *Serpentine* River:' **Be it therefore Enacted** by the King's most Excellent Majesty, by and with the Advice and Consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the Authority of the same, That the said Commissioners of Sewers for the Time being, or such Number of them as are authorized to act by virtue of the said Commission of Sewers, shall, within Nine Calendar Months from the passing of this Act, cause to be constructed a Wear or Tumbling Bay of the Height of Two Feet across the said Brook called the *Bayswater* or *Westbourn Brook*, at or near the Spot where the said Brook crosses the Road at *Bayswater*, and shall also cause to be constructed a Tunnel Drain or Sewer from such Tumbling Bay along the *Uxbridge Road* aforesaid to the Tunnel Sewer nearly opposite the End of *Albion-street*, *Uxbridge Road*, which passes through *Hyde Park* aforesaid, and communicates with the open Watercourse or Sewer called *Ranelagh Sewer*, so that all the Water Drainage and Soil passing down the said Brook (and not passing over such Wear) may pass along

Commissioners of Sewers empowered to make a Wear and Sewer.

such Tunnel Sewer so to be made as aforesaid, such Tunnel Sewer to be Six Feet high and Four Feet Six Inches wide at the least, and to be constructed in all other respects as the said Commissioners shall think fit; and the same and the Tumbling Bay, when finished, shall become Part of the Public Sewers under the Jurisdiction of the said Commissioners.

Commissioners empowered to enter upon Premises for the Purposes of the Act.

II. And be it further Enacted, That, for the Purpose of carrying this Act into effect, the said Commissioners of Sewers shall have full Power and Authority by virtue of this Act to enter upon any Part of the said Road, and to cause to be constructed in any Part thereof all such Works as the said Commissioners shall deem necessary for effecting the Purposes of this Act.

Commissioners of Sewers to have the same Powers as before the passing of the Act.

III. And be it further Enacted, That, for the purpose of carrying into effect the Powers and Directions in this Act contained, the said Commissioners of Sewers shall have all and every the Powers which they possessed before the passing of this Act, either by virtue of the aforesaid Commission, or of any Law, Statute, or Usage, now in force, and such Powers shall be applicable to this Act.

IV. And be it further Enacted, That for defraying

Commissioners empowered to borrow Money from Exchequer Loan Commissioners.

One Moiety of the Expenses of the Works hereby directed to be done, the said Commissioners of Sewers may from Time to Time borrow and take up at Interest, on the Credit of the Rates to be made and levied by virtue of this Act or of any other Act now in force, any Sum or Sums, not exceeding in the whole the Sum of Three thousand five hundred Pounds, from the Commissioners for carrying into execution an Act passed in the Fifty-seventh Year of the Reign of King *George* the Third, intituled, "*An Act to authorize the Issue of Exchequer Bills and the Advance of Money out of the Consolidated Fund, to a limited Amount, for the carrying on of Public Works and Fisheries in the United Kingdom, and Employment of the Poor in* Great Britain," and several subsequent Acts for extending and amending the Powers for the issuing of Exchequer Bills for Public Works; and the said last-mentioned Commissioners are hereby authorized and required to advance and lend the same accordingly.

57 Geo. 3. c. 34.

Rate of Interest to be paid.

V. **And be it further Enacted**, That Interest shall be paid on the Amount of the Money so to be advanced by the said Commissioners for issuing Exchequer Bills to the Commissioners acting under this Act, or on so much thereof as shall for the Time being remain due and unpaid, after the Rate of

Four Pounds *per Centum per Annum*, any thing in the said Acts for the issuing of Exchequer Bills, or any of them, to the contrary notwithstanding; and that the principal Money so advanced shall be repaid by Twenty equal yearly Instalments, the first of such Instalments to be paid at the Expiration of Twelve Calendar Months from the time of advancing the said Money.

Commissioners of Sewers empowered to levy Rates.

VI. **And be it further Enacted**, That it shall and may be lawful for the said Commissioners of Sewers acting under this Act, and they are hereby authorized and required, to make, impose, and levy, on all Lands, Houses, Shops, Warehouses, Coach-houses, Stables, or other Buildings, Yards, and Gardens, within the said Parishes of *Saint Mary Paddington* and *Saint Mary-le-bone*, and the Parishes of *Saint John Hampstead* and *Willesden*, in the said County of *Middlesex*, draining into or using or in any way benefited by the said *Bayswater* or *Westbourn Brook*, or which Lands, Houses, Shops, Warehouses, Coach-houses, Stables, or other Buildings, shall or may drain into, use, or in any way be benefited by the same, or drain into or use or in any way be benefited by the Tunnel Sewer hereby directed to be made, in the Opinion of the said Commissioners of Sewers, all such Rates, Taxes, or Assessments, as shall be necessary for the Re-payment of the said Principal Sum or Sums of Money so to be borrowed as aforesaid, and the Interest thereon, and after such Rate, and in such Proportions, and in such Manner, as they shall think fit.

Commissioners of Sewers empowered to assign Rates.

VII. **And be it further Enacted**, That it shall and may be lawful for the said Commissioners of Sewers from Time to Time, by Writing under their Hands and Seals, or of any Six or more of them, to assign all or any Part of the said Rates, Taxes, or Assessments, to the said Commissioners for issuing Exchequer Bills, on their advancing any such Sum or Sums as aforesaid, as a Security for the Principal Money so to be advanced, and the Interest for the same.

Commissioners of Woods and Forests may advance any Sum not exceeding £3500. for defraying a Moiety of the Expenses incurred under this Act.

VIII. **And be it further Enacted**, That for defraying the remaining Moiety of the Expenses of the Works hereby directed to be done, it shall be lawful for the Commissioners for the Time being of His Majesty's Woods, Forests, Land Revenues, Works, and Buildings, on behalf of His Majesty, and they are hereby authorized and directed, to advance and pay to the said Commissioners of Sewers, out of the Funds of the Crown under their Control and Management, any Sum or Sums necessary for defraying One Moiety of the Expenses of the aforesaid Works, not exceeding in the whole the Sum of Three thousand Five hundred Pounds.

A distinct Account to be kept of the Monies expended under this Act.

IX. **Provided always, and be it further Enacted,** That the said Commissioners of Sewers shall and they are hereby required to keep a separate and distinct Account of all Monies expended by them in making and completing the said Sewer and other Works by this Act authorised to be made.

Printed by J. Smith, 49, Long Acre.

INSTITUTION OF CIVIL ENGINEERS.

ADDRESS

OF

SIR JOHN RENNIE,

PRESIDENT,

TO THE

ANNUAL GENERAL MEETING,

JANUARY 20, 1846.

LONDON:
PUBLISHED AT THE INSTITUTION.

1846.

LONDON:
Printed by WILLIAM CLOWES and SONS,
Stamford Street.

ADDRESS OF SIR JOHN RENNIE, PRESIDENT,

TO THE

ANNUAL GENERAL MEETING,

JANUARY 20, 1846.

SINCE I last had the honour of addressing you from this Chair, another year has elapsed. The Institution has continued to prosper, and our profession, from which it emanated, and by which it is supported, continues to extend its sphere of usefulness; and its importance, which becomes daily more and more acknowledged, renders our future prospects equally cheering. Before I attempt to point out the course which it behoves us to pursue as regards ulterior proceedings, let us pause and take a retrospective glance at the changes which have been effected in Great Britain since the days of that great man Smeaton, to whose genius and exertions Civil Engineering may be said to owe its establishment as a profession in this country. Previous to that period (1724), Great Britain may be said, comparatively speaking, to have been lamentably deficient in public works. There were no canals, railways, nor artificial harbours, or machinery, which at the present day would be thought worthy of the name; and the public roads were little better than mere tracks across the country. Communication between towns was difficult; and the few wheeled carriages in use were of a rude and inefficient description. The inland commerce of the country was chiefly carried on by transport on the backs of "*pack horses;*" and the old-fashioned term *load*, so commonly in use as a measure or weight, is a remnant of that custom—meaning a horse load. The luxuries, and even necessaries of life, were, consequently, extremely dear and difficult of attainment. Inland navigation, which was carried on in the rivers as nature had left them, was both tedious and uncertain; and this navigation, imperfect as it was, could only be adopted at times when there was sufficient water, arising from floods, or other causes; occasionally (but of this the instances were very rare) rude temporary stanches, or flash-weirs, were used to pen up the running water in shallow places; these weirs, or stanches, were then suddenly withdrawn, and thus the increased depth of water and the current enabled the boats to float over them; these were followed by rough unwalled locks; then by short side-cuts to avoid the difficult places of the rivers; in these side-cuts the pound-lock was introduced, with side-weirs to enable the floods to escape, and to supply mills with water, thus answering the double purposes of navigation and supplying power for machinery.

The above may be taken as the extent of improvement to which inland navigation had arrived in Great Britain up to the middle of the last century. The navigation of the ocean, depending upon the inconstant agency of the winds and tides, required months, nay, years, for communicating between distant quarters of the globe. The reckoning of a ship's course, during a long voyage, was most uncertain; neither chronometers, nor lunar observations, nor accurate instruments for making such observations, were known.

The Steam Engine (to the honour of inventing which so many individuals lay claim) had, in 1698, been so far improved, and was, for the first time, constructed by Savery so as to be employed as an efficient agent for raising water, was brought into active operation, in 1712, by means of a steam cylinder, into which cold water was injected for causing a vacuum, so as to enable a moveable piston to be impelled by the pressure of the atmosphere, and thus, by the intervention of a lever, to work pumps for raising water; this was further improved by Potter and Beighton (1713–18), so as to become self-acting; and thus Newcomen's engine, by degrees, became generally adopted for pumping water from collieries, and from a few rich mines, and for supplying the metropolis with water; but the consumption and expense of fuel was so considerable that, even great as were the advantages derived from its employment, still its application was very limited. After Beighton, followed Leupold, Hulls, Belidor, Payne, Blake, Fitzgerald, Emerson, and others, who made various suggestions, without, however, adding anything material to the engine as improved by Newcomen, Potter, and Beighton. The relation between the quantity of fuel consumed and the effect produced by an engine, had never been determined; and knowledge was wanting for the investigation of the important subject, until Black and Cavendish, in 1760-62, had made their experiments and discoveries on the combination of heat with bodies in their solid, liquid, and gaseous states. Notwithstanding the great advantages resulting from the employment of Newcomen's engine, still, for the reasons above mentioned, its application was very limited; wind and water were alone used as powers for driving machinery and working mills, which were rare, and only adapted for performing rude mechanical operations, such as grinding corn, fulling cloth, pumping water, blowing furnaces, hammering and rolling iron, and such other purposes as the feeble powers of human labour were unable to accomplish; and with the exception of the silk mills introduced from Italy by Sir Thomas Lombe at Derby in 1720, and which were worked by water, there was nothing in the nature of manufacturing machinery.

Smeaton, born in 1724, at an early age applied his ingenious and vigorous mind to the cultivation of philosophical knowledge, and thought for the benefit of mankind. He commenced his career as a mathematical-instrument maker in 1750; after obtaining some celebrity in the scientific world by his air-pump in 1752, he took up the subject of wind and water-mills, which had, up to that period, been much neglected, and soon made such improvements in them as greatly increased their powers and efficiency; he constructed several of both kinds according to his improved principles with great success, which were considered as models, and soon afterwards universally followed. In 1753 he was elected Fellow of the Royal Society; in 1759 he communicated his celebrated paper (being the results of his experiments in 1752 and 1753) on the natural powers of wind and water to turn mills and other machinery depending on circular motion, for which he obtained their gold medal. These improvements of Smeaton were of manifold importance, and produced, directly and indirectly, the most beneficial results, as they enabled a greater quantity of work to be performed both by wind and water, particularly during temperate and dry seasons; hence, better roads became necessary to carry away the increased produce of the mills; and when they were worked by water on rivers, the mill-owner became interested in the improvement of the navigation, and, by economising the water on Smeaton's plan, obtained one-third greater result with the same quantity, thus benefiting himself as well as the navigation. Windmills have been rendered still more perfect than Smeaton left them, by making them self-regulating as to the extent of the surface of their sails presented to the action of the wind, according to the form and mode invented by Meikle in 1772; by Bywater in 1804, with an improved mode of clothing the sails; and still further by our valuable member, Cubitt, in 1807, who brought the system to perfection. Smeaton was amongst the first to point out the laws which govern the formation and maintenance of harbours; and, after undertaking a voyage of observation through Holland, he introduced great improvements in the draining of marsh lands (as at Holderness and the North Level), a subject which had up to that period been very imperfectly understood; and, by the design and construction of the celebrated Edystone lighthouse in 1755-59, Smeaton introduced a new era in masonry, which forms a brilliant epoch in his valuable life, spent in the service of mankind, but more particularly for the benefit of his country.

In 1765 Smeaton directed his attention to Newcomen's engine, and constructed a small engine, at his own house at Austhorpe, in order to conduct his experiments and obtain more accurate results in practice. By the judicious improvements which he introduced in the proportions and structure, he diminished materially the consumption of fuel, then an object of paramount importance, and soon after constructed engines on Newcomen's principle, which far exceeded anything of the kind hitherto produced: amongst these may be mentioned the engines at Long Benton, near Newcastle, and at Chasewater, in Cornwall; he thus rendered the system of Newcomen as perfect as it could be made. From the improvements of Smeaton on wind and water mills, we may date the foundation of the modern system of manufacturing, and from those in Newcomen's engine the modern system of mining.

In 1736 Watt was born, and from his early years manifested symptoms of that genius and sagacity which, at a later period, enabled him to work out, with wonderful success, those grand discoveries which have immortalized his name. He began his career as a mathematical instrument maker, and subsequently became an Engineer. He proposed a plan for improving the river Clyde, and suggested the idea of the Caledonian Canal, but afterwards devoted himself almost exclusively to the improvement of the steam-engine. His improvements, or rather inventions, may be stated, generally, as follows:—the separate condensing vessel, with an air-pump for exhausting the steam cylinder, instead of injecting cold water into it for impelling the piston on Newcomen's plan, by atmospheric pressure; in conjunction with Boulton, he brought these improvements into operation about the year 1773, and produced a still greater diminution in the consumption of fuel than Smeaton had done, thus rendering the application of the steam-engine for pumping water much more general. In 1781 he invented the means of producing rotatory motion by the steam-engine, first by the crank, and afterwards by the sun and planet wheel, thus rendering it applicable for the purpose of driving all kinds of machinery, which was a grand step towards the improvement of manufactures. In 1777-82 he invented the application of steam, with expansive action and with double action, alternately above and below the piston. In 1784 he invented the parallel motion, or working gear and valves, the governor, and other important details. All these improvements or inventions were carried into effect in an engine made by Boulton and Watt, in 1784, for one of the London breweries, and in 1785 in others for the Albion mills, which were the first steam-mills, now become so general; thus steam power was rendered available for working machinery of every kind, by following the best examples of this most wonderful and useful of all machines, which has so deservedly immortalized the name of Watt. The account of the extraordinary labours and inventions of Watt and his successors is well given by our valuable member, Farey, in his excellent work on the steam-engine, to which I would refer you, and also to the treaties by Tredgold, Arago, Scott Russell, and others.

About this period (1716), Brindley, who may be justly called the father of inland canal navigation in England, was born. He commenced his career as a millwright, and was withdrawn from that occupation by the Duke of Bridgewater in 1758, for the purpose of executing his great canal. Pound locks had been introduced long before on river navigations, and on the Exeter and Topsham Canal, which was commenced in 1581, and terminated about 1695; they were also used on the Sankey Canal in 1755, for the purpose of rendering Sankey Brook navigable; which was effected by making an almost entirely new channel. Brindley subsequently executed, with great success, the Trent and Mersey, or Grand Trunk, the Leeds and Liverpool, the Birmingham, the Forth and Clyde canals, in conjunction with Smeaton and several others, with all the necessary works belonging to them, which will ever remain as lasting monuments of his skill and genius in this valuable department of Civil Engineering. At an early period of the reign of George III., the importance of canal navigation became universally acknowledged as one of the greatest means, then known, of facilitating the transport and reducing the cost of the necessaries and luxuries of life, and thus contributing to the wealth and prosperity of every part of the kingdom; those prejudices and obstacles by which, at the outset, every great improvement is surrounded, gradually began to give way, canals became popular, and superseded river navigation so much as to call forth the celebrated answer of Brindley to the question, "What is the use of rivers?"—"To supply canals." Engineers who had displayed such abilities in planning and executing works of the nature above described, began to acquire that importance as a profession which was soon after destined to work such a beneficial change, nay, almost a revolution in society, and accelerate so greatly the civilization of mankind.

Smeaton and Brindley were accompanied and followed by a number of able men in rapid succession; amongst whom Jessop, Whitworth, Mylne, Yeoman, Henshall, Golborne, Huddart, Rennie, Ralph Walker, Chapman, Telford, and others, all stimulated to exertion by the magnificent career before them, each contributing, more or less according to their several opportunities, great skill and invention of their own, in addition to that acquired from their predecessors. Favoured by the command of great funds (which were rapidly forthcoming as the success of the works already executed became manifest), better workmen and materials, new and improved machinery, steam power, and greater influence over the public mind, their operations were conducted upon a scale of magnitude, utility, and importance which gave a new character to the age in which they flourished, and advanced the prosperity of the empire.

To attempt to enumerate all the various public works which then crowded each other in rapid succession, constituting the character of the profession, and entitling it to public confidence, would be both difficult and tedious; they are well known and duly appreciated, and it will suffice to point out some of the most important. The Forth and Clyde Canal by Smeaton, (1768,) length 24 miles, depth 8 feet, locks 19 feet by 75 feet, top-width of canal 66 feet; the Ellesmere by Jessop and Telford, with its magnificent aqueduct across the Dee near Llangollen, consisting of 19 arches 40 feet span, the centre being 126 feet above the Dee, with a total length of 1020 feet, and a width of 12 feet, the piers of stone, and the arches and aqueduct of cast iron; the Caledonian Canal by Jessop and Telford, 22 miles long, depth 16 feet, locks 40 feet wide by 172 feet long, 8 feet rise, top-width of canal 110 feet; locks intended for a depth of 20 feet; commenced in 1803, opened October, 1820; the first and last of which, together with the Gloucester and Berkley Canal, may be cited as the first upon which sea-borne vessels could navigate, and thus extend the benefits of ship navigation into the interior of the country, without the delay and expense of transhipment of cargoes until arriving at the warehouses whence they are to be distributed. The Grand Junction (Jessop and Whitworth), Lancaster, and Kennet and Avon (Rennie). On the Lancaster navigation the canal is carried across the Lune by a stone viaduct of 5 semi-circular arches, 75 feet span each; the total length of viaduct is 600 feet, and height 55 feet above the river. The Aire and Calder, the Union, the Shrewsbury, New Birmingham and Liverpool, Carlisle, the Grand and Royal Canals, Ireland, amongst many others may be quoted as examples of artificial canals for vessels, so as to enable them to continue their navigation inland from large rivers and estuaries. The total length of canal navigation now in operation in England, Scotland, and Ireland, amounts to about 3,000 miles. The most advantageous speed for boats on a canal is about 2½ miles per hour, at which rate an average horse is capable of drawing about 22 tons without injuring his physical powers; when this is much exceeded, the ratio of resistance approaches the cube of the velocity. The weight must be diminished in proportion, and the horse exerts his powers to great disadvantage. Large canals, where practicable, on account of the trade and other circumstances, are preferable to small ones, as they are worked more economically. Various contrivances have been made to obviate the necessity of locks in overcoming extensive lifts or declivities, amongst these may be mentioned the inclined planes on the Duke of Bridgewater's and the Tamar and Shrewsbury canals. Double locks, side ponds, hydraulic lifts, by Woodhouse, Salmon, Congreve, Underhill, Green, and others; but extensive reservoirs and feeders are indispensable in most districts where there is great traffic, and steam-engines have been extensively used to pump back the water to be used over again in case of deficiency. The improvement of the River Clyde, begun by Watt and Golborne, received fresh stimulus under Rennie and Telford, from the application of steam power to the dredging-machine by Grimshaw, in 1796, and Bentham in 1802; thus forming a new era in the means of improving river navigation and harbours, since which this important department of engineering has been carried to an extent which could not otherwise have been attempted. Steam-dredging machinery is now generally adopted with success, more particularly in rivers where their beds and channels can be excavated to a certain degree of uniformity, and where the inclination of the tidal and fresh-water currents can be reduced to such an extent, by the removal of obstructions, as will enable them to keep their channels open. As successful examples of this, I need only adduce the Lagan, the Boyne, the Newry, the Liffey, and the Shannon, in Ireland. The Clyde, the Leith, the Don, in Scotland. The Tyne, the Wear, the Tees, the Thames, the Dee, the Ribble, the Severn, and others, in England; and as to harbours, most, if not all, of them can be maintained by steam-dredging, in addition to other means, to a greater depth than could be obtained without such an important aid.

As regards Bridges.—Westminster Bridge, by Labelye in 1740-47, may be considered the first example of extensive structures of this kind. It consists of 13 semicircular arches (the centre of which is 75 feet span), 1164 feet long; it was originally intended for a wooden bridge, and was partly commenced on this principle; it was a great work at the time, but as might have been expected, contained defects, particularly in the foundations, which at that time were but imperfectly understood, and have suffered much by the scour of the current; it will probably be rebuilt in a short time. Caissons, or water-tight chests, were first introduced there for the purpose of founding the piers below the level of low water. Previous to this, the principal existing bridges consisted of a number of small Gothic or of circular arches, with rough piers of masonry built either upon a foundation of loose rubble stones thrown promiscuously into the river until sufficiently high and solid, or upon timber platforms resting upon piles surrounded by large bulwarks of timber, filled with loose stones, called starlings, which materially contracted the water-way where they were placed, and by causing increased rapidity in the current, created great obstacles to the navigation, as well as to the drainage of the adjacent country. Of this, the well-known examples of Old London Bridge, those at Newcastle-upon-Tyne, Rochester, and Belfast, may be mentioned. All these, with the exception of Rochester Bridge, are now removed, and are replaced with others constructed upon the modern improved principles. Westminster Bridge was followed by that of Blackfriars by Mylne (1760-71), consisting of 9 semi-elliptical arches, the largest of which is 100 feet span and 41 feet 6 inches rise; the total length of the bridge is 995 feet, and 45 feet wide; here the elliptical arch was introduced about the first time in this country. Smeaton's bridges of Coldstream across the Tweed, in 1763, composed of 5 circular arches, the largest of which is 61 feet span; that over the Tay at Perth, in 1766, of 9 circular arches, the largest of which is 75 feet span; at Hexham, over the Tyne, in 1767, of 9 circular arches, the largest of which is 52 feet span, and others, for that period, were works of considerable magnitude. These were followed by numerous smaller works all over the kingdom, more remarkable for convenience and utility than for any peculiarity in their construction worthy of notice, until in 1809-1817, when Waterloo Bridge, across the Thames, consisting of nine equal semi-elliptical arches, 120 feet upon each, and 35 feet rise, was built of granite in a style of solidity and magnificence hitherto unknown; there the elliptical arch, with inverted arches between them to counteract the lateral pressure, was carried to a greater extent than in former bridges, and isolated coffer-dams upon a great scale in a tidal river, with steam-engines for pumping out the water, were, it is believed for the first time, employed in this country; the level line of roadway, which adds so much to the beauty as well as the convenience of the structure, was there adopted. The bridge across the Severn at Gloucester, in 1828, by Telford, is worthy of remark, as being the first with one arch, of 150 feet span, like those of the bridge across the Seine at

Neuilly, near Paris, by Perronet, where the interior of the arch is elliptical and the exterior circular.

New London Bridge (1825-1831), consisting of five semi-elliptical arches, viz., two of 130 feet, two of 140 feet, and the centre 152 feet 6 inches span, and 37 feet 6 inches rise, is perhaps the largest elliptical arch ever attempted; the roadway is 52 feet wide. This bridge deserves remark on account of the difficult situation in which it was built, being immediately above the Old Bridge, in a depth of from 25 feet to 30 feet at low water, on a soft alluvial bottom, covered with large loose stones, scoured away by the force of the current from the foundation of the Old Bridge, the whole of which had to be removed by dredging, before the coffer-dams for the piers and abutments could be commenced, otherwise it would have been extremely difficult, if not impracticable, to have made them water-tight; the difficulty was further increased by the Old Bridge being left standing, to accommodate the traffic, whilst the New Bridge was building, and the restricted water-way of the Old Bridge occasioned such an increased velocity of the current, as materially to retard the operations of the New Bridge, and at times the tide threatened to carry away all before it. The great magnitude and extreme flatness of the arches demanded unusual care in the selection of the materials, which were of the finest blue and white granite from Scotland and Devonshire; great accuracy in the workmanship was also indispensable. The piers and abutments stand upon platforms of timber resting upon piles about 20 feet long. The masonry is from 8 feet to 10 feet below the bed of the river.

I will conclude this division of the subject with the celebrated bridge across the Dee at Chester. It consists of a single arch, the segment of a circle 200 feet span, with a versed sine or rise of 42 feet, which is the largest stone arch upon record; the arch stones at the crown are 4 feet 6 inches deep, and 7 feet at the springing, and the abutments on both sides of the river are founded on new red sandstone. The centre for building the arch was remarkable for its simplicity, strength, and rigidity, by which means the greatest effect was produced by the smallest quantity of timber, and any change of form, so prejudicial in centres, was prevented. This fine structure is due (it is believed) to the combined talents and energies of the late Mr. Harrison, the architect, of Chester, who made the original design; to Mr. George Rennie, who equilibrated the arch, gave the proper dimensions of the voussoirs and form and dimensions of the abutments, the mode of constructing them, and designed the centre, the original model of which is now in our gallery; and to Mr. Jesse Hartley and Mr. Trubshaw, who worked out the details, and carried the whole into effect.

A proper theory of the equilibrium of the arch, which shall satisfy all the conditions of the question, when applied to practice, may be said to be still wanting, though much valuable information may be derived from the scientific works of Hutton, Attwood, Moseley, Gwilt, and others, on the subject.

Oblique or skew bridges have but recently obtained extensive use. Chapman built some in Ireland many years ago, and wrote an account of his mode of constructing them. On railways they were introduced by Stephenson, and are now generally employed. Buck's excellent treatise on the principles and practice of their construction greatly facilitated their execution.

Iron Bridges.—The introduction of cast iron for the construction of bridges commenced about the year 1779, when that over the Severn, near Coalbrook Dale, by Darby, was the first; it consists of a circular arch 100 feet span, and a versed sine of 45 feet, approaching nearly to a semicircle; the height of the springing is 10 feet above low water, and the total height to the underside of the soffit is 55 feet; the banks of the Severn being high, this form accords well with them. It is formed by five ribs of cast iron, with perpendicular spandril pieces, resting upon them to support the roadway. This, for a first attempt, is well adapted to the situation, and has answered the purpose. This was followed by the bridge over the Wear, at Sunderland: the design for this was said originally to have been made by Thomas Paine, the well-known political writer, and was cast at Rotherham, being intended for erection in America; but the materials were subequently employed in constructing Sunderland Bridge, under the direction of Wilson, in 1796, the idea having been suggested by Rowland Burdon. The curve of the arch is that of a segment of a circle, the length of the chord or span is 200 feet, and the versed sine or rise 30 feet, the total height from low water to the underside of the soffit of the arch is nearly 100 feet. It consists of six ribs, each composed of 105 cast-iron radiating pieces, connected at the top and bottom by the circular pieces which form the curve of the arch; these ribs are united in their transverse direction by tie-pieces; the spandrils are filled in with cast-iron circles, touching each other at their circumferences, and supporting the roadway, which consists of a strong frame of timber, planked over and covered with a cement of tar and chalk, upon which a layer of marl limestone and gravel is placed. The centre deserves notice on account of the difficulty and confined nature of the situation, which rendered it necessary to preserve a constant passage for ships with their standing rigging; this was effected by a perpendicular framing resting upon piles in the bed of river, with a sufficient opening on each side for the vessels. Upon the top of this perpendicular framing, the transverse framing or centre for supporting the arch was fixed, and answered its purpose well. Some time after the removal of the centre, the arch was observed to swerve bodily in a horizontal direction to the eastward, forming a curve having a versed sine of about 12 or 18 inches; if this had continued to increase, it would no doubt have soon occasioned the downfall of the structure; it was, however, very skilfully remedied by the introduction of transverse and diagonal tie bars and braces, assisted by wedges and screws, so that ultimately the whole was brought back and secured in its original form and position, where it has since remained in a substantial state without alteration. The width of the bridge is 30 feet; the abutments are of stone, founded on rock; they are 24 feet thick, and from 42 feet to 37 feet wide. This bridge, for boldness of the design and construction, as well as for its elegance and lightness, must be considered a work of peculiar merit; particularly if the period in which it was constructed be remembered.

About the same time the bridge at Buildwas, across the Severn, by Telford, was erected. It consists of a single arch, segment of a circle, whose chord or span is 130 feet, and versed sine or rise 27 feet, the depth of the iron frame forming the arch being 3 feet 10 inches; it consists of three ribs, 18 feet wide from out to out, connected together in their transverse direction by tie-bars. The spandrils for supporting the roadway consist of vertical pieces, resting upon the segments forming the arch; the abutments are of stone. There is a novelty in the construction of this bridge worthy of remark. The two outer ribs consist of two segments of circles each struck from different centres, the crown of one terminating immediately below the roadway, the other at the top of the parapet, so that the platform forming the roadway is both suspended and insistent. The object of this being, it is presumed, to increase the depth of the truss supporting the roadway, and thus to add to the strength of the bridge; but it was unnecessary, and does not appear to have been adopted in any of Telford's subsequent designs, which are numerous. Amongst them may be mentioned that of Bonar, Tewkesbury bridge over the Severn, also that over the Dee, near Corwen, &c. Bristol bridge over the Avon, by Jessop, is a neat simple structure. Boston bridge, by Rennie, over the Witham, of 100 feet span, with a versed sine of 4 feet, is remarkable for its boldness and lightness. The principle of construction resembles that of Sunderland, but is an improvement upon it, in having a better system of transverse and diagonal braces, and the spandrils consisting of vertical instead of circular pieces. All these have, however, been far exceeded by the Southwark bridge over the Thames, by Rennie. This consists of three arches, all segments of the same circle; the centre arch is 240 feet span, with a versed sine or rise of 24 feet, and the two side arches are 210 feet span each, with a versed sine or rise of 18 feet 10 inches each. The arches are formed by eight solid ribs in each, and each rib consisting of fifteen pieces, 6 feet deep at the crown of the arch, increasing to 8 feet deep at the springing, 2½ inches thick in the middle, and 4½ at the top and bottom: these ribs are connected together in their transverse direction by cast-iron tie-braces of the same depth as the ribs, but open in the centre, and in the diagonal direction by another series of ribs; the whole of the segmental pieces forming the arch, as well as the transverse and diagonal tie-braces, are kept in their places by dovetailed sockets and long cast-iron wedges, so that bolts for holding the several pieces together are unnecessary, although they were used during the construction of the bridge to keep the pieces in their places until the wedges had been driven. Thus the ribs formed, as it were, a series of hollow masses or voussoirs similar to those of stone; a principle which it is believed is new in the construction of cast-iron bridges, but it has succeeded so well that it is worthy of adoption elsewhere. The spandrils are composed of cast-iron diagonal pieces, connected together in a similar manner, and the roadway is formed by solid plates of cast-iron resting upon the spandrils, and joined together by iron cement. The piers and abutments are of stone, founded upon timber platforms, resting upon bearing piles, and surrounded by sheathing piles, driven sufficiently deep below the bed of the river. The masonry is tied throughout by vertical and horizontal bond stones, so that the whole acts as one mass in the best position to resist the horizontal thrust. The ribs forming the arches were commenced in the centre, and were continued regularly on each side towards the piers and abutments, upon which a cast-iron bed and connecting plate were laid, nicely let into the masonry to receive the ribs forming the arches; when the last segment of each rib was fixed in its place, three cast-iron wedges, each 9 feet long and 9 inches wide, were placed behind each rib, and nicely adjusted and fitted to them; these having a very slight taper, were driven simultaneously by heavy hammers, and thus the arches were nearly lifted from the centres, so that the wooden wedges upon which the segment pieces rested were easily removed by a few blows of a hammer; the arches were thus relieved from the centres in a very simple and efficient manner. The whole of the iron-work had been so well put together by Messrs. Walker, of Rotherham, the founders, and the masonry by the contractors, Messrs. Jolliffe and Banks, that when the work was finished, scarcely any sinking was discernible in the arches. During the progress of the work, some experiments were made, in order to ascertain the extent of the expansion and contraction between the extreme range of winter and summer temperature, and upon taking the average of numerous trials by different gauges, it was found that the crown of the arch rose in the summer about an inch to an inch and a half. The work was commenced in 1813, and the bridge was opened in 1819.

Whilst upon the subject of cast-iron bridges, we must not omit the Swivel or Turning Bridge. The invention, if it may be so termed, is, it is believed, due to England, and one was first made of iron about the year 1810. They are now ulmost universally adopted over locks, to the extent of 50 feet span, in preference to the old lifting bridge. Since the introduction of the railway system, cast-iron bridges have become very general, and have been particularly serviceable, being formed of girders, where the height was too limited to admit of the arch principle being adopted. Experience of the value of wrought iron in roofs and for other building purposes has induced R. Stephenson to propose that material for constructing the bridge to carry the Chester and Holyhead Railway across the Menai Straits. His design consists of a close wrought-iron tunnel or tube, 14 feet wide, 30 feet deep, and 1500 feet long, supported in the middle by a stone pier built upon a rock in the middle of the Straits, with two other piers at the low-water mark on either side, leaving four openings, two of them 460 feet, and two of 230 feet each, and 100 feet above high water, so as to admit of masted vessels sailing under it. Cubitt has also proposed to adopt wrought iron on a great scale, for constructing landing platforms at Liverpool, where the difficulty of building docks or quays, which large steam-vessels can approach at all times of tide, render works of this kind necessary to accommodate the immense traffic frequenting Liverpool. The landing platform designed by Cubitt, and now in course of construction, consists of a wooden frame, 500 feet long by 80 feet wide, floated upon a number of wrought-iron pontoons, each 80 feet long, 10 feet wide, and 6 feet deep; it is connected with the shore by two bridges, each formed of two hollow wrought-iron beams, 150 feet long, carrying the platform of the bridge; the attachment with the shore and the stage is so made as to admit of motion, both vertically and horizontally, to accommodate itself to the rising, falling, ebbing, and flowing of the tide, which there rises about 30 feet.

Suspension Bridges.—The invention of chain or suspension bridges is said to have been imported from China and India. The first of the kind in England was that across the Tees, at Middleton, consisting of two common chains stretched across the river, and secured to the adjoining rocky banks; the span was 70 feet. To Captain Sir Samuel Brown, however, who had previously brought chain cables into use for ships, may be attributed the introduction into England of the improved system of the bar link, which is now so generally adopted. Brown, in 1818, first constructed a large model of 100 feet span, capable of supporting a carriage and horses, indeed adapted for general traffic. He afterwards constructed (1819), upon this principle, Union bridge for general traffic across the Tweed, near Berwick; the span was 450 feet between the supporting towers, which were of masonry. He subsequently built another, of smaller dimensions, across the Tweed, at Dryburgh. He also constructed that at Montrose, one over the Hundred Feet river in the Fens, and others, and applied the same principle with effect for landing-piers at Brighton and Leith. This system was afterwards carried out to a far greater extent by Telford, in his great suspension bridge across the Menai, at Bangor, in 1818-20, so well described by Provis. It consists of three openings, the centre is 580 feet span, the deflection of the chain being 42 feet, and the two side openings are 260 feet span each, the platform of the roadway is 100 feet above high-water mark; the sustaining towers of masonry are 50 feet above the roadway, and are connected to the shore by three stone arches on one side, and four on the other, 52 feet 6 inches span each. There are 16 main chains 1770 feet long each, in sets of 4 each, suspended above each other, on each side of the roadway, which is 30 feet wide from out to out, divided into three parts, two for carriages, on the outside, 12 feet wide each, and one for foot-passengers in the middle, 6 feet wide. Each main chain consists of 5 bars or links, 10 feet long each, by 3½ inches and 1½ inches, connected together by plates and pins, on Brown's system, the whole being properly secured to the solid rock on each side. The total suspended weight of the main opening is 644 tons. About the same time he constructed another, upon similar principles, 300 feet span, across the river Conway, at Conway. These are fine works, and will remain as lasting monuments to his fame. The recent structures of Hammersmith, across the Thames, and Shoreham across the Adour, by Tierney Clark, who is now erecting another upon a grander scale, 700 feet span, across the Danube; and, lastly, that of Brunel across the Thames, at Hungerford Market (1845), show the progress made in this class of structures, which are well adapted for crossing large and deep rivers where economy is an object; great care, however, is necessary in proportioning the strength of the chains, and their curve; the selection and manufacturing of the iron for them, and also in the connexion and bracing of the road-way platform, in order to insure the greatest strength and solidity of construction; of this, the improvements to the Montrose Bridge, by Rendel, is a good example, and the system should be generally followed, as several disastrous failures have occurred from neglect of these important particulars.

Amongst variations of the system, that of Dredge may be mentioned.

The wire suspension system, although in extensive use on the Continent, the largest example of which is at Fribourg, in Switzerland, where a bridge has been constructed of 800 feet span, for carriages as well as foot passengers, has been rarely used in this country. Although economical in the first cost, it requires constant attention, and it scarcely possesses sufficient durability for permanent structures.

In wooden bridges, little was formerly done in Britain beyond the common pile bridge. These were formed by rows of piles for piers, driven at short distances from each other, and connected together by straight girders planked across to form the roadway, with a wooden railing on each side. Of this kind of construction, the bridges of Londonderry, across the Foyle, Waterford, across the Suir, Battersea, Fulham, and others, across the Thames, are examples. In some cases, this system was extended by adopting larger openings, having diagonal struts, or butting pieces, between the underside of the girders and the piles forming the piers, in order to reduce the bearing of the girders, and thus give them greater stability. The straight trussed frame or girder, so much used in America, was employed by Rennie, to a considerable extent, as service bridges, during the construction of the Waterloo and Southwark bridges, in 1809–19, and at New London Bridge, in 1825–31, with openings of above 100 feet, capable of supporting the heaviest weights. The late Colonel By, of the Royal Engineers, gave an account of a bridge of this description, said to have been built across the Terrebonne, a large river near Montreal, in Canada, 600 feet span between the piers. It is said that this was carried into effect, and actually stood for a short time; but in consequence of its having been badly constructed, it required heavy repairs, and whilst these were being effected, the whole structure came down, and was carried away by the floods. The trussed system has been applied with considerable success in some well-constructed bridges across the Tyne, for the Newcastle and Carlisle Railway, by Blackmore, and in several other places. The system of Wiebiking, of combining small curved pieces of timber connected together in the form of an arch, adapted for large spans, was first introduced, I believe, on the Ancholme, in 1826, when a bridge of 100 feet span was constructed with complete success. This has been used by Green, in the viaducts for the Newcastle and North Shields Railway; and has been followed by others also. Price, long ago, proposed a similar system ; but the scarcity and dearness of timber, and the prevalent use of iron, probably prevented its application before. The lattice bridge, of American origin, has latterly been introduced on the Birmingham and Gloucester Railway, by Moorsom, and on the Dublin and Drogheda Railway by McNeil, and as they are economical and simple in their construction, they are applicable in some cases with advantage.

In the designing and constructing of bridges of stone, wood, cast and wrought iron, an accurate knowledge of the strength of materials is peculiarly important, nay absolutely indispensable; and the profession is much indebted to George Rennie, who commenced a series of investigations on this subject in 1817, which were communicated to the Royal Society, and published in their Transactions in 1818. These experiments were amongst the first to determine with precision the absolute and relative strengths of materials, under the effects of tension and compression. He subsequently made above six hundred experiments in 1827 on the friction of plane and round surfaces, with and without unguents, under the different circumstances of time, surface, and pressure, which were published in the Philosophical Transactions, in 1828. In 1830 he also made experiments on the friction and resistance of fluids, which were published in 1831. Morin's experiments did not appear until 1834 —Tredgold, Barlow, Fairbairn, Hodgkinson, Wood, and others, have since carried these experiments to a greater extent.

Concrete, a mixture of gravel, sand, lime, and other cements in certain proportions, was well known to the ancients, and in conjunction with the invaluable natural cement, Pozzolana, was applied with the greatest success in the then numerous moles and other submarine works, and its use has been still continued in Italy to the present day. Wren is said to have used it for a portion of the foundation of St. Paul's, where it was defective. Semple also alludes to it in 1776. Its use appears to have been discontinued for a time, but recently to have been resumed. Rennie proposed it for the foundation of the Penitentiary in 1811; Smirke and others followed in the same track, and now the employment of concrete for the foundations of buildings has become nearly universal, wherever it is necessary.

Brick has been much used for bridges over canals and drains by Rennie, and in railway bridges by Stephenson, Cubitt, Locke, Rastrick, and others; and, latterly, it has been carried to a far greater extent by Brunel in his bridge across the Thames at Maidenhead, for the Great Western Railway. It consists of two semi-elliptical arches, each 130 feet span, and rising 24 feet; they are built wholly of brick, in Roman cement.

Roman cement, discovered by Parker, in 1796, is chiefly made from a stone found on the shores of the Isle of Sheppy, near Sheerness; it is burnt in a kiln, and when ground into fine powder, possesses the peculiar property of setting hard immediately, although exposed to water, which renders it very valuable in hydraulic works. It had been little used in public works until it was adopted by Rennie and others. It was extensively employed in the naval works at Sheerness and elsewhere, and is now universally employed in buildings where immediate induration or setting is required, in order to prevent the action of water, or where any settlement from insistent weight would be injurious. Latterly Roman cement stone has been found at Harwich and other places. Aberthaw, Lyme, Barrow and other limestones also possess valuable properties for water-works. The success of buildings depends materially upon the cement or mortar employed; and much has been done by Smeaton, Rennie, and Telford in the selection of the best lime, sand, and other materials, in combining them in proper proportions for the respective parts of the works where they were employed, and in the application of machinery for the more thoroughly mixing up and incorporating the materials together. Great credit is also due to Higgins, Pasley, Donaldson, Smith and Godwin for their valuable experiments and treatises upon this important subject.*

Additional strength has been given to brick structures, by the introduction of bands of thin hoop iron between the courses; this improvement was first generally introduced by Sir M. I. Brunel.

Tunnels.—Subterranean tunnels have been much used in inland navigation, particularly in the Duke of Bridgewater's Canal, some miles of which, at Worsley, are made under ground; in the Harecastle Tunnel, by Brindley, on the Trent and Mersey Canal, in 1776, which was rendered more convenient by Telford, in 1826, by adding another parallel to it, of larger dimensions; in the Huddersfield Canal, where there is a tunnel 5280 yards long; in the Braunston Tunnel, on the Grand Junction Canal, and many others: all of these, however, have been surpassed by the Tunnel under the Thames, at Rotherhithe, by Sir Isambard Brunel, which, for magnitude, boldness in the design, and ingenuity in the means of construction, as well as the extraordinary difficulties by which the work was attended, will long remain a lasting monument of the talents and perseverance of that celebrated and ingenious engineer. This extraordinary work was commenced in 1825; it consists of two arched openings 1200 feet in length, 14 feet span each, 16 feet 4 inches high, separated from each other by a pier 4 feet thick, having sixty-four lateral arches of 4 feet span, to communicate between the main openings, the whole being surrounded with massive walls. The external dimensions of the walls, including the openings, are 38 feet wide, and 22 feet high. It is approached at each end by a perpendicular shaft, 50 feet diameter, and 80 feet deep; but the tunnel was intended hereafter to be carried out to the surface of the adjoining streets, at such a moderate inclination that carriages could easily pass through it from both sides of the river. The crown of the tunnel is about 16 feet below the bed of the river. In order to carry into effect this very difficult work, unusual means and precautions were necessary. The ordinary wooden centre framing scarcely presented sufficient strength and connexion for that purpose. Brunel, accordingly, invented a cast-iron framing (which he termed a shield) sufficiently large to embrace the whole width and height of the intended structure, and divided into thirty-six compartments, each sufficiently large for a man to work in, yet capable of being closed to prevent the access of water when required; the whole was impelled forward by powerful screws, bearing upon the work behind, as it was finished. This ingenious contrivance was perfectly successful; and although the works were twice stopped by the irruption of the Thames, nevertheless the apertures were stopped by bags of clay and other materials, and the structure was continued with extraordinary perseverance until finally completed and opened to the public in 1843. The whole was constructed with bricks set in Roman cement, and cased inside with the same material; and it gives every prospect of permanence and solidity.

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* From the valuable researches of these authors it appears, that the hydraulic cements contain considerable portions of silica and alumina, and in some cases metallic oxides; and, where natural hydraulic cements cannot be obtained, they may be produced artificially, by the combination of these ingredients in the proper proportions.

A tunnel under the Thames had been previously proposed at Rotherhithe by Trevethick, and had advanced to some distance under the river, when it was abandoned; also one by Dodd at Graveseend, which was scarcely commenced. A tunnel was also carried to a considerable extent under the Severn, at Newnham, but failed for want of funds.

Tunnels form part of the works of almost every considerable railway, and the art of constructing them with accuracy and expedition is now brought to great perfection. Amongst the most remarkable tunnels executed upon railways, may be mentioned that at Kilsby, 2398 yards long, on the Birmingham and London line, by Stephenson; that at Box Hill, 3195 yards long, on the Great Western Railway, by Brunel; and that on the Sheffield and Manchester line, 5280 yards long, by Locke; several others of great length are now in progress.

Harbours.—In the construction of harbours, Smeaton, as already observed, had pointed out the proper course, in his Reports on Lynn, Wells, Aberdeen, Dundee, Dunbar, Port Patrick, Sandwich, Scarborough, Sunderland, Workington, Rye, Dover, and others. Ramsgate harbour was originally designed by Labelye in 1744; it had been partly executed by others, and continued with little success through a tedious succession of years, with various changes of plan, until 1774, when it was placed under Smeaton's direction; he soon saw the evil arising from the constant accumulation of mud which threatened to fill it up, in consequence of there being no back-water or scouring power to remove it. He therefore divided the harbour into two parts by a cross wall; the part next the shore formed a basin of eleven acres, in which the water could be retained by means of a lock, and discharged through powerful sluices in the cross wall into the outer harbour at low water, and thus form an effectual scouring power for removing the mud. Here was the introduction of a new principle for the maintenance of harbours, which is so difficult on an alluvial coast, operated upon by the tides and currents; and although previously in use on the Continent, it is believed to be the first example of the kind in Great Britain. Smeaton afterwards continued the works, and introduced an improved system of masonry; in 1788, he founded the outer and inner walls of the outer piers, below low water, by means of caissons or boxes of wood, and so far improved the diving-bell as to render it useful in carrying on the operations, although he did not build with it; and about the same time he used it for examining the foundations of the piers of Hexham bridge, one of which had partially sunk. The late Mr. Rennie, who after Smeaton's decease took charge of the works at Ramsgate, profiting by what had been done, carried out the system to a greater extent, by enlarging the sluices and making them of cast iron, the old ones being of wood and frequently out of repair; a greater quantity of water could then be discharged in the same time, when required, and thus act with greater effect; or the discharge could be prolonged, according to circumstances. The masonry also, which, although good for the early period at which it was constructed, had become dilapidated, was rebuilt, where requisite, in a much more substantial manner. The steam-dredging machine was also applied to remove that portion of the mud which could not be effected by the sluices. The diving-bell was afterwards perfected by Rennie, so as to be perfectly manageable, and being suspended from a frame worked by proper machinery, it could be raised and lowered, or moved laterally, in any direction, with facility and promptitude, either according to the directions of the diver within the bell, communicated by means of signals, made by striking the sides of the bell with a hammer, or given by the superintendent above. All the operations for preparing a foundation, and afterwards laying the prepared blocks of masonry upon it, could thus be performed with as much certainty below as above the water. Rennie first used his improved apparatus in 1813 for rebuilding the advanced East Pier Head at Ramsgate Harbour, which was founded 17 feet below low water of spring tides with complete success. The value of this invention for sub-marine operations was now completely established, and he afterwards employed it with advantage in founding the pier heads and outer walls of Holyhead, Howth, and Sheerness Harbours, and other works under his direction, and it is now generally adopted in all similar circumstances. The diving-helmets and dresses, improved by Deane, Bethell, Edwards, Seibe, and others, have also materially contributed to the success of sub-marine operations.

After Smeaton, numerous artificial harbours were designed and constructed, and natural ones improved; amongst the former may be mentioned Holyhead, Howth, and Kingstown; at the latter there is a depth of 26 feet at low water of spring tides, and an enclosed area of 250 acres at low water; which is the largest harbour attempted in this country by Rennie. Here and at Howth he substituted the flat slope for the upright wall to resist the waves,* and introduced the plan of throwing down loose blocks of rubble, or unhewn stone, for forming the main body of the piers, allowing the slope or angle of repose, at which the materials would lie, to be formed by the sea. In his system of making low-water harbours, which, up to that period, were almost unknown in Great Britain, he adopted the plan of enclosing the area by piers composed of several straight arms or lengths, intersecting each other according to particular angles, instead of making them curved, which, in his opinion, only served to increase the action of the waves. In asylum harbours, when practicable, as at Kingstown, he preferred making the entrance open to the dangerous wind, thus rendering them more accessible for vessels in distress; but in order to prevent the prejudicial effects of any waves which might roll into the harbours, he adopted the returning and inclined form of entrance, by which means increased facility of entrance and departure was also given. He also designed his harbours with a view to preserving the original depth, as far as practicable, which is a principle of the greatest importance, and ought not to be lost sight of. The artificial harbours of Ardrossan, the Troon, Peterhead, by Telford, Scarborough, by Chapman, Hartlepool, and others, are worthy of remark.

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* This system was latterly always adopted by Rennie and Telford in preference to the upright wall, as being better adapted to resist waves, and it has been invariably successful, wherever it has been properly carried into effect.

In the improvement of natural harbours, may be mentioned Sunderland, Berwick, Aberdeen, Dublin, Newry, Drogheda, Leith, Belfast, and others. The principle generally adopted has been to confine and direct the tidal and fresh waters, by piers, in proper and sufficient channels, whence they are discharged into the ocean, so as to enable them to act with greater effect in counteracting the baneful effects of the antagonist operations of the winds, waves, and sand, brought in from the sea; also to increase, as far as practicable, the receptacle for tidal and fresh waters, and to dispose of them in such a manner that they shall act with effect in maintaining and preserving the channels. These operations, as in the case of the Clyde, are materially assisted by the employment of that invaluable auxiliary, the steam-dredging machine, which ought to be attached to every harbour. I must not omit to mention the breakwater in Plymouth Sound, by Rennie and Whidbey, which is the first and largest example of a detached mole or breakwater in this country. It is a mile long, constructed in a depth varying from 5 to 8 fathoms at low water, formed of loose blocks of rubble, of all sizes, up to 10 or 12 tons weight each, thrown into the sea to form their own base and slope, according to the action of the waves. The surface from low water mark to its full height, which is 2 feet above high water, has been paved with masonry, and at the base of the sea slope, at the level of low water, there is a berm or benching to protect it. At the western extremity a light-house has been built, to point out the western or principal entrance to the Sound, and a beacon on the eastern extremity points out the east entrance. The whole of the work, except a portion of the masonry, which is granite, has been built of limestone, brought from the adjoining shores. The intention of the work was to protect the Sound against the heavy swell, which formerly used to roll in with considerable violence during strong westerly and south-westerly gales; this object has been completely obtained, and the roadstead has been rendered perfectly secure. The work has been eminently successful in every respect, for besides obtaining the desired protection, the original depth of water has been preserved, the facility of ingress and egress has not been diminished, but rather increased, and the cost has corresponded as nearly as possible with the original estimate.

Another class of harbours, called Floating or Wet Docks, for receiving merchant vessels out of the tide or sea-way, was first introduced at Liverpool about the year 1716, and wet docks have been since constructed in almost all the principal ports of the kingdom--viz., London, Bristol, Hull, Leith, Sunderland, as well as for the

Royal Navy at Portsmouth, Plymouth, Sheerness, Chatham, and Woolwich. The East and West India Docks, by Jessop, Rennie, and Ralph Walker; the London, Leith, and Dublin, by Rennie; St. Catherine's, London, by Telford; the New Docks at Liverpool, by Hartley; at Hull, by James Walker; at Cardiff, by Cubitt; at Newport, by Green; at Southampton, by Giles; and the great works now in progress at Birkenhead, on the Mersey, opposite Liverpool, and at Great Grimsby, by Rendel, are magnificent examples of private enterprise for facilitating the commerce of the empire. The design of Rennie for a grand naval arsenal on the Thames, at Northfleet, immediately above Gravesend, intended as a substitute for the imperfect naval establishments at Deptford, Woolwich, Sheerness, and Chatham, is worthy of remark. This magnificent design consisted of six capacious basins, with a total surface of 600 acres within the walls, the largest being 4000 feet long, and 1000 feet wide, and covering 87 acres; the whole to communicate with each other, and be provided with capacious quays, dry docks, building-slips, and storehouses; steam machinery for manufacturing cordage, blocks, anchors, flour and bread, sawing and converting timber, pumping, and working cranes; in fact, for almost every operation connected with the naval service, and so systematically arranged and disposed, that the required operations should succeed each other with the greatest dispatch and economy, whether of time, labour, or cost. The estimate was £11,000,000, which was perhaps more than would have been required: any portion could have been executed as it was wanted, without interfering with the general plan. It is to be regretted that this plan was not carried into effect, for it would have repaid the cost in the increased economy of fitting out fleets, and since that period about £5,000,000 have been expended on the old establishments in the Thames and Medway, with a small degree of benefit, compared with what would have been obtained from Northfleet. His design also for the improvement and enlargement of Chatham Dockyard is worthy of remark. It consisted of a new channel to be made for the Medway below Rochester Bridge, and converting the bend of the river, in front of the Dockyard, into a magnificent floating dock of above 100 acres, and from thence making a canal, 1½ mile long, 300 feet wide, and 30 feet deep, to the deep water in the Medway at Gillingham, by which means vessels of war of the largest class could come to the Dockyard with the whole of their armament, which they cannot do now; the course to sea would have been shortened, and the shallow water of the Medway avoided: thus Chatham Dockyard would have been rendered the most convenient and extensive in Europe, and its proximity to London by a railway would have rendered the yards at Deptford and Woolwich unnecessary. The estimate for this work was only £700,000, whereas since that time fully as much, if not more, has been spent upon Woolwich, with a very inferior result; indeed, it is not even too late to undertake this plan for Chatham now, and would well repay the expenditure. In designing and carrying into effect this important class of public works, so as to render them successful, a thorough knowledge of the nature and operation of tides, winds, currents, soundings, and all the departments of hydrography, physical geography, and geology is necessary, and in these sciences much is due to the exertions of Beaufort, Bullock, Washington, Denham, Buckland, De la Bèche, Lyell, Greenough, Sedgwick, Murchison, Phillips, and others.

Revetments, or Retaining Walls.—These, until near the latter end of the last century, had been usually built with horizontal foundations and courses, the interior side being almost vertical, and the exterior with a flat face and very little batter, or in many cases vertical. The curved face retaining wall was latterly introduced, with the foundation and courses inclining from the horizontal, so as to conform with the radius of curvature; this form of wall is preferable, in many cases, to the old, as combining greater strength with a less section, and being more convenient in other respects, and was commonly used by Rennie in his various works, when applicable.

To whom the introduction of this improved form of wall is due it is difficult to ascertain with accuracy; but Rennie, Ralph Walker, and Jessop were amongst the first who brought it into use. A further improvement was made in the retaining walls used at Sheerness in 1815 by Rennie, where the foundation being composed of soft alluvial mud and quicksand, to a great depth, more than usual precautions were necessary to render the walls substantial and secure. The object was effected by enlarging the base, and making the interior hollow, like a caisson, with the bottom in the form of an inverted dome; the outer or river face being concave, and the foundation, for a certain width, laid reclining at right angles to a tangent from the curved face of the front of the wall; the remainder of the foundation was horizontal, and the back or land side of the wall was vertical. Thus there was both a front and back wall connected together by cross walls, forming one mass; the inverted arches or domes under the hollow spaces being filled with chalk and gravel concrete, and the whole resting upon a well-connected platform of piles and cross-beams and planking. By thus distributing the same quantity of materials over a greater surface, the vertical weight per square foot was reduced, and the desired stability was obtained upon this very difficult and treacherous foundation. Rennie had previously tried, with success, a wall of a similar principle, and under similar circumstances at Grimsby. General Bentham also tried a similar principle, about the same time, which was not so successful, in consequence of an unsuitable form and construction.

The coffer-dams which Rennie employed for constructing the walls at Sheerness are worthy of remark, as being the most extensive and difficult that had been constructed up to that period. The bottom being soft mud to a considerable depth, piles of 60 feet to 80 feet in length, were necessary, and when driven and braced in their places as far as practicable, chain bars and raking-shores from the land were requisite, in order to counteract the alternate pressure inwards and falling outwards, occasioned by the badness of the foundation and the heavy shocks of the waves to which they were exposed. In order to break the effects of the sea during storms, he employed a series of old men-of-war hulks, to act as floating breakwaters; these were useful to a certain extent, so long as they held firm in their places; but at times, during heavy gales, they dragged their moorings, and driving against the dams, occasioned considerable damage; upon the whole, however, they were useful.* In order to give greater security to the dams, and to prevent leakage, a considerable quantity of grooved and tongued sheathing-piles were necessary for the works; and to effect this, he invented a machine worked by a steam-engine, which answered the purpose effectually, at a cost of one-sixth of the price of manual labour, and as it was unsafe to withdraw any of the coffer-dam piles, he made another machine for cutting them off at the ground level, below low water, which was also found very useful.

The dams for founding the sea-locks of the Caledonian Canal at Fort William and near Inverness, by Telford, are worthy of remark. In the former case, great difficulties arose, in consequence of the foundation being rock, at some depth below low water; this was overcome by ingeniously securing the piles to the rock; and in the latter case, where the bottom was soft mud, the difficulty was obviated by bringing cargoes or masses of earth and clay from a considerable distance, and afterwards driving the piles through the made ground. The great dam, 1000 feet in length, for building the foundations of the river-wall and New Houses of Parliament, by James Walker, is another good example. The late Peter Ewart was among the first who introduced cast and wrought iron for dams, for piling in general, and for wharfs; it has been since employed by Walker, Sibley, Stevenson, and others, in many situations, with great success. At the Albion Mills, already mentioned as the first steam-mill constructed in 1785, by Watt and Rennie, on the banks of the Thames, close to Blackfriars Bridge, the foundation being soft mud and moving sand, inverted arches were formed upon the ground, between the foundation courses of the walls, so that the whole area of the building obtained support by the same weight resting upon an increased base.

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* Floating breakwaters of timber have latterly been tried, as a substitute for more solid constructions, but they have not hitherto succeeded.

Drainage.—In works of draining extensive districts of low marsh or fen lands, the Romans, with their usual energy and ability, effected much, and the Po-dike, Caer-dike, and the embankment of the Thames, amongst other works, are good examples. After they left the country, it relapsed into its former state of barbarism, and so remained for ages, until the art of drainage may be said to have been lost. Upon its revival the Dutch, from necessity, had become extremely skilful, and were celebrated throughout Europe at a remote period, almost before engineering commenced in Great Britain. On account of the proximity to England, and their experience in these kind of works, when it became a question of draining the extensive districts of low marshy land on the east coast of England bordering upon the Humber, the Witham, the Ancholme, the Welland, the Nene, and the Ouse, it was natural that recourse should be had to those who, from their skill and experience, had already acquired such reputation as the Dutch; accordingly we find, in the reign of Charles the First (when it was determined to drain the great level of the fens, afterwards called the Bedford Level, from the name of the Earls of Bedford,) Cornelius Vermuyden came over from Holland, and after draining the level of Hatfield Chase, adjoining the Trent, and acquiring considerable celebrity and influence, was knighted by the king. He planned great works in 1640, at the Bedford Level, for Francis Earl of Bedford, but the execution of Vermuyden's plans were prevented by the Civil War, and were afterwards carried into effect by William, the successor to Francis, Earl of Bedford, after much discussion and controversy, and were successful in draining the level to a certain extent. The plan in 1651 consisted in placing a sluice across the River Ouse, at Denver, about 15 miles from the sea at Lynn, where the Ouse enters the Great Wash, so as to exclude the tidal waters, leaving the channel of the River Ouse, above that sluice, for discharging the fresh waters only; these it was proposed to conduct from all parts of the land by small lateral drains or canals, carried to the river in as direct courses as practicable, having sluices at their junction with the river, to prevent the floods from entering them and covering the adjacent lands. He also cut a new channel, about 20 miles long, called the Bedford, or Hundred Foot River, for a part of the River Ouse, from the point where Denver Sluice was erected, to the old channel of the Ouse, at Earith, where another stanch or sluice was placed for preventing the tide from going beyond that point.

Vermuyden considered that by adopting this plan, and having only the fresh waters to contend with, he would get rid of that most powerful enemy to drainage, the tide; and then, having only to deal with the fresh water, he anticipated no difficulty in accomplishing the complete drainage of the land. For a time the plan answered tolerably well, and effected considerable improvement in the drainage; but he overlooked the important facts that the tidal waters formed the most important agent in keeping open the channels of the rivers, in preserving a good outfall for the drainage waters to the sea; that by excluding the tidal waters, the channel of the rivers would suffer, in proportion to the quantity of water which was thus abstracted from them, and that thus in time they would become incapable of effectually discharging the drainage waters; that the outfalls of the rivers would also suffer in the same proportion, and then the marsh-land districts, depending upon them for their drainage, would revert to their former inefficient state, and so it happened with the Bedford Level. The mouth of the channel of the River Ouse, which is the chief outfall for the drainage of the district where the Bedford Level is situated, being deprived of its accustomed and natural scouring power of tidal water, became so obstructed by shoals, that the land waters could not pass off to the sea. In proportion as the drainage became defective in process of time, as it necessarily did under the system adopted, windmills were erected to work scoop-wheels, with a lift of 4 or 5 feet, for raising the water out of the lateral canals into the river. In 1713, Denver Sluice was undermined and blown up by the floods, and the tide recovered, to a certain extent, its ancient receptacles, and if proper measures had then been adopted, both the drainage and the navigation would have been restored to an efficient state; but the sluice was rebuilt after a few years on the old system, and the drainage and navigation became deteriorated as before. During the past century the drainage of the Bedford Level, as well as other districts, has been submitted to, and has occupied in succession the attention of the ablest engineers of the day; among whom may be mentioned the names of Perry, Elstobb, Grundy, Golborne, Armstrong, Kinderly, Smeaton, Jessop, Chapman, Page, Robert and William Mylne, Huddart, Rennie, Telford, Walker, G. and J. Rennie, Cubitt, Rendel, and others.

Amongst the most remarkable operations of this nature, may be mentioned the works upon the river Ouse, for the purpose of improving the drainage and navigation, which had become seriously affected by the accumulation of sands at its mouth, and the abstraction of the tidal waters above mentioned. The principal defect existed immediately above the town of Lynn, where the river took an extraordinary bend almost at right angles to its general course, for a length of 5¼ miles, forming almost a semicircle, the diameter of which was only 2¼ miles; independently, moreover, of this circuitous course by which so much fall or inclination of the current was lost, the channel was so irregular and disproportionate in width, and so much encumbered with shifting sands, that the tidal and fresh waters were unable to force their way through them; thus the drainage waters were penned up above, and being unable to get off, formed a tranquil pool, which during floods frequently broke the banks and inundated the surrounding country, the channel, moreover, being deprived of its natural scour, silted up in the same proportion. In order to obviate this great and growing evil, the ablest engineers of the day were consulted, and they unanimously concurred in the opinion, that the only sure means of providing a remedy was to cut off the bend in the Ouse, by making the shortest channel between its two extremities. This plan was first proposed by Bridgeman, in the year 1724, and was subsequently recommended by the various engineers of the day who succeeded him. In the year 1792, an Act was passed, after great opposition, empowering a certain body of Commissioners to carry into effect this cut, which was called the Eau Brink Cut, the expenses of which, estimated at about £80,000, were to be defrayed by a tax of 4*d*. per acre on the middle and south levels of the Bedford Level, comprising about 300,000 acres of land drained by the Ouse. This great work was to have been carried into effect by Robert Mylne and Sir Thomas Hyde Page; but they disagreed as to the proper form and dimensions of the cut, and referred the matter to Captain Huddart, who decided between them; so much money, however, had been spent in litigation, that the tax which was levied to pay for its execution was exhausted. In 1817, another Act of Parliament was obtained, empowering certain Commissioners to raise additional and increased funds from the lands which it was supposed would be benefited by it, and the execution of the work with its branches was intrusted to the late Mr. Rennie, as the principal engineer. The Eau Brink Cut, which was executed according to the award of Huddart, and the works connected with it, were finished and opened on the 19th of July, 1821, and very beneficial effects, as had been anticipated, immediately followed; the extraordinary wet winter of 1821 which succeeded, proved its success beyond doubt, for soon after the cut was opened the low-water line in the Ouse, immediately above it, fell five feet, which necessarily produced a corresponding increase in the fall or inclination in the current, and thus gave it increased velocity and power to scour away and remove the obstacles in the bed of the river, and to discharge a greater quantity of water in the same time, as well as a longer period for discharging it, to the great benefit of the country drained by it. The tidal waters, moreover, being freed from the shifting sands and circuitous course of the old channel, and being confined in one mass in the new direct channel, acted with greater effect; finding their way upwards, and becoming united with the fresh waters in enlarging and deepening the channel above, they kept it open to its proper dimensions, and thus both the drainage and the navigation derived benefit from this great work. The improvement was carried still further, in adding one-third to the dimensions of the cut, particularly at the upper end; by this means an additional fall of about 2 feet 6 inches was obtained, making a total increase of about 7 feet 6 inches in the fall of the current at the upper end. The effect of these improvements has been to increase greatly the produce and value of upwards of 300,000 acres of land drained by the Ouse, which otherwise could not have been cultivated. The measure, like almost all other great improvements, encountered great opposition at the time, and in order to tranquillise the fears of some and satisfy the prejudices of others, various minor interior works were provided, such as locks and weirs, for penning up the water, most of which, but for existing prejudices, it would have been better to have dispensed with, and to have removed Denver sluice, raising the banks on the various rivers above, so as to have restored them to their natural state, and thus by admitting a greater quantity of tidal water, to have scoured out their channels, and thereby have enabled them to carry off the drainage waters more effectually.

A similar operation was executed by Telford and Rennie, on the river Nene, in 1829, at the Nene outfall, which commences about five miles below Wisbeach, and terminates at Skate's Corner, a length of nearly 5 miles, where it joins the great estuary of the Wash. The beneficial effects of this work have been very extraordinary; the low-water mark has been lowered 10 feet 6 inches, and a district of above 100,000 acres has been completely drained and brought into cultivation, which formerly for the greater part of the year was little better than a stagnant marsh; the navigation has been so much improved, that the tide rises 14 feet at Wisbeach, and vessels of 200 tons are now enabled to come up to that town, where previously the river was only navigable for small sloops; and at Sutton Bridge, 8 miles lower down, vessels of above 600 tons can arrive where formerly there was only water for vessels of 200 tons.

The river Nene having been thus improved, so as to enable it to carry off the tidal and fresh waters, an extensive plan for the interior drainage was designed and carried into effect by Telford, in 1830. It consisted of one main drain of proper dimensions, with two subsidiary drains of smaller capacity, extending above 20 miles, as far as Thorney, to bring down and discharge all the water from the low fen-land districts into the upper end of the new outfall, by means of a capacious new sluice with self-acting gates, which continues to discharge the water from the drains into the Nene, so long as the level of the water in the drain is higher than that of the river; but whenever the water in the river is higher, the sluice-gates close and prevent the river water from entering. This plan of Telford's resembled one previously proposed by Rennie for the same object, but which was upon a more extensive scale, and was accompanied by the important addition of catch-water drains.

In 1806, Rennie proposed and carried into effect a complete system of drainage, for an extensive district of fen-land, called the East, West, and Wildmore Fens, bordering upon the river Witham into which they drained, about 10 miles above Boston. Rennie at once perceived the defects of the Witham as a means of drainage and navigation, and decided that until the river was improved by shortening its course and increasing the capacity of its channel, the complete drainage could not be affected. This plan he proposed, but the opposition was so strenuous that he was obliged to abandon it, and to carry his main drains into the river below the town of Boston: he divided the drains into two classes; one set he technically termed catch-water drains, which running along the base of the hills surrounding the low lands, intercepted all the high land waters, which, descending with great velocity, would soon have overwhelmed the low lands, in addition to the water falling upon them according to the extent of their surfaces. These high land waters were conducted by the catch-water drains into a main drain, which discharged the waters, by a self-acting sluice, into the Witham immediately below Boston; the low land waters thus freed from the high land waters, were conducted by separate drains into another main drain at Hobhole, about 3 miles lower down the Witham, where there was more fall. By this means both classes of waters were discharged without interfering with each other; means were also secured of discharging all the water by the lower drain at Hobhole, in case it should be found necessary, which ultimately happened, and it was made of additional capacity for that object. The district was thus completely drained, and from a stagnant marsh was converted into corn-fields.

The Witham being left to itself, became silted up in 1827, as had been foreseen by Rennie, and the neap tides scarcely flowed above 3 to 4 feet at Boston. The channel was then improved as recommended by him, and the river is now in such a state that vessels drawing 12 and 14 feet arrive at Boston, and the whole country drained by the Witham has been proportionably benefited.

He proposed a similar plan for the improvement of the Great Bedford Level in 1811, the cost of which he estimated at £1,188,189; but unfortunately for that district it has never yet been carried into effect, although it would have amply repaid the outlay. The origin of the above system, it is believed, is due to Rennie, although it is said by some that the Romans employed catch-water drains, and the Caer-dike is quoted as an example: it is, however, by no means clear whether it was not merely a navigable canal to connect the Nene and the Witham; at all events, the system, if ever it existed, had long been abandoned, and the revival, at least, in modern times, is due to him. He also proposed the drainage of the Hatfield Chase and Ancholme districts, and Romney Marsh,* Holdernesse, and other districts upon similar principles, where drainage had been tried and had only partially succeeded.

After mature consideration and experience, it appears that the safest and most certain principles of drainage and navigation are:—The improvement of the channels and outfalls of the rivers, as far as may be practicable, for the free admission and discharge of the tidal and fresh waters; with interior drains, well laid out, of proper proportion and capacity for the low land, and catch-water drains for the high land waters, and according to circumstances, the drainage and navigation may be combined or kept seperate.

Steam Drainage.—Where natural drainage could not be effected, or was only imperfectly applied, recourse was had to windmills and scoop wheels, as still used in Holland; these were always adopted until 1820, when Watt's steam-engine was successfully applied by Rennie to work a large scoop-wheel, for draining Bottisham Fen, near Ely. Subsequently this valuable system has been applied and extended by Glynn, Field and others, to the great improvement of fen-lands, by draining the water lower beneath the surface than could be done by windmills, which are now almost generally superseded by steam engines; the latter can be used when required, whereas the windmills can only be employed when there is wind; and it frequently happens that calms prevail during rainy weather, at the very time when the mills are most wanted.

Whilst carrying out the improvements of the outfalls and mouths of rivers, it often occurs that large tracts of sand and mud may be converted into fine arable land, fit for agricultural purposes, by accelerating the natural accumulation of warp, or alluvial matter, held in mechanical suspension by the water, and which, from the absence of proper measures, is otherwise carried away without producing any benefit. The works for this object and for improving the drainage and navigation, if properly conducted, consist generally in regulating and confining the channels of the rivers, through the sands below high-water mark, to one channel, for both the flood and ebb waters, and accelerating gradually the accumulation of alluvial deposit, by jetties and other light works adjacent to them; in proportion as the deposit accumulates, the works are raised until vegetation appears, which generally takes place about the level of high water of neap tides, and then the land is embanked from the sea. The system of warping or artificially soiling bad land where the levels will permit, has been practised for many years along the Trent, Ouse, and Humber, with considerable success. The operation consists in admitting, through sluices and canals made for the purpose, the water charged with alluvial matter in suspension, to the lands to be warped, which are surrounded with embankments, and after having deposited the alluvial matter the waters are conducted away again to the river; this process is repeated at intervals until the lands have been sufficiently warped, and thus lands which, in some cases, are situated several miles from the rivers, and were comparatively worth little, have become extremely valuable. If these operations be judiciously conducted, the outfalls of the rivers, and the harbours and drainage and navigation depending on them, may be greatly improved, and the land gained during the operation will, in many cases, amply repay the cost of gaining it. In Holland, and other countries, there is a great field open: much depends upon the situation and other local circumstances; considerable judgment and skill is required in selecting the districts, and in properly applying the system, but its consequences are so important that it is well worthy of the attention of engineers. A scheme of this kind upon an extensive scale is about being carried into effect at the mouth of the Ouse and Nene, where above 30,000 acres of land will be gained, and great improvement will be effected in the drainage and navigation of the extensive districts drained by the Ouse and Nene. The same principle is applicable, in some cases, for converting shoals into effective breakwaters.

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* The difficulties here are peculiar, in consequence of the coast being surrounded with a broad belt of loose shingle, which renders it necessary to carry the drainage water through the sea banks by close tunnels, with valves at their outer extremities, so as to be forced open by the hydraulic pressure of the water, Dymchurch wall, or sea-bank, here is well worthy of remark: it was formed in the Dutch manner by stakes wattled together, and constantly required repair; it has since been faced with stone paving, at an inclination of about 6 to 1, which stands well, and resists effectually the heavy seas to which it is exposed.

Machinery and Manufactures.—The improvement and extension of machinery and manufactures by new inventions and applications have been immense since the time of Smeaton. Previous to that period wood was almost exclusively used in the construction of machinery. Desaguliers, Leupold, Gravesande and other writers, have given descriptions of the best specimens of mills and machinery in use a century ago, but they were very defective, both in proportion and construction, when compared with modern machinery for similar purposes. The introduction of cast iron by Smeaton, in 1754, was a great step in advance. He began by employing cast iron for the axis of one of his earliest windmills, in 1754; then in 1769, for the shaft of a water-wheel, and the main-wheel attached to it, for boring cannon at Carron; cast iron afterwards was generally adopted for axes, but as some of them, which were improperly made, gave way, the application of cast iron in other machinery was in some measure retarded, until Watt applied his steam-engine to drive mills. The Albion Mills, constructed by Rennie, in 1784, and worked by Watt's steam-engine, may be considered as the first complete example of the employment of iron in every part of machinery, except for the teeth of some of the wheels, which were made of hard wood, for working into the iron teeth of other wheels; that example also showing the true form of teeth, with a fine pitch, and adequate depth and breadth and adjustment with each other, so as to work well together with the least friction, and the use of bevel gear, which is the perfection of modern millwork.

The great improvement effected in the design, proportion, and construction of millwork, together with the steam-engine, enabled machinery to be driven with greater velocity, increased action, and diminished friction, and thus greater effect was produced with the same amount of power.

We are indebted to our honorary member, Professor Willis, for his able investigation of the teeth of wheels, and to Whewell, Mosely, Jamieson, G. Rennie (for his new edition of Buchanan), and others, for their valuable treatises on mechanical and engineering subjects.

The invention of the spinning-jenny by Hargreaves, in 1767, and of the means of drawing out the fibres of cotton between successive pairs of revolving rollers in the water-twist spinning, by Arkwright, in 1769, followed by his system of machinery for carding and preparing fibres of cotton for spinning, in 1775, occasioned a complete revolution in the arts of manufacturing, and led to the establishment of the factory system, with its self-acting machinery. A somewhat similar system had, however, been introduced in the Silk Mills at Derby nearly half a century before; but inasmuch as silk naturally consists of a series of fine threads, it is only necessary to twist or retwist them, in order to combine them together, which is a very simple operation, compared with forming the short detached fibres of cotton into a thread, without the aid of the hand to guide them; and to accomplish this by machinery was extremely difficult; it was, however, very ingeniously overcome by Hargreaves and Arkwright in different ways, both of which were combined together by Crompton in the mule in 1771. Arkwright's water-spinning was subsequently simplified into what is technically termed throstle-spinning, and together with his preparing machinery of 1775, was adopted for spinning worsted by Toplis, and for flax by Marshall. The carding machinery was also adopted, with suitable modifications, for preparing short wool, Hargreaves' spinning-jenny being used for spinning it into yarn for woollen cloth. The mule for a long while was only employed for cotton, but was adapted by Kelly in 1790, to be partly worked by power in aid of manual labour, and was soon after improved so as to spin extremely fine threads.

All these valuable inventions, together with a multiplicity of other ingenious contrivances connected with the factory system, were completed and brought into extensive use in the short period of twenty years. Machinery for printing calico was introduced by Peel, and perfected by others. Watt, in 1787, introduced chemical bleaching, which was afterwards carried to great perfection by Tennant. Cartwright, in 1787, invented cloth-weaving by power, although it was not brought into use until twenty years after, and, in 1790, he invented machinery for combing and preparing long wool, in prepation for being spun into worsted. Machinery for dressing woollen cloth by teazles was perfected, and Harmer invented machinery for shearing it in 1787. This has since been carried to greater perfection by Lewis. Bramah, in 1796, introduced the hydraulic press, which furnished the means of pressing cloth, books, papers, and other articles with a degree of force which could be accomplished by no other means, and its general adoption has been of great service. Self-acting machines for making button-shanks were invented by Heaton. Boulton's large manufactory at Soho contained many inventions besides those of Watt. He invented machinery for coining money by steam power in 1790, and erected a complete establishment at Soho, where, for a long time, he executed contracts for coining money for the British, and various foreign governments. His plan for stamping the pieces, consisted in exhausting air by pumps worked by a steam-engine, from vessels properly adapted for the purpose, and connected by valves with air cylinders, having pistons working the balance-beams of the coining-presses. By opening a valve, air is exhausted from within the cylinder, and the atmospheric pressure acting upon the piston, turns down the screw of the press which stamps the coin; by re-admitting air, the piston rises and with it the screw, thus producing an alternate rising and falling motion so as to strike from 50 to 60 pieces per minute; as the screw rises and falls, it works a feeding apparatus for supplying blank pieces, ready prepared for stamping, and as fast as one piece is stamped it is pushed off the die, and is replaced by another. The apparatus for cutting out the blank pieces is of a similar description; the whole is self-acting, and is a most beautiful and ingenious contrivance. These improvements were introduced into the Royal Mint, at Tower Hill, which was constructed in 1810, under the direction of Messrs. Boulton and Watt, who furnished the steam-engines and the coining machinery. The rolling machinery by Rennie, and the equalizing machinery of Barton, constructed by Maudslay, complete this magnificent establishment. At St. Petersburg, Copenhagen, Calcutta, and Bombay, Messrs. Boulton and Watt erected similar establishments, with rolling-mills by Rennie, at the two latter places.

The whole of the above ingenious and valuable inventions, except power-weaving, had been fully carried out and brought into successful practice before the end of last century. The brilliant results which were obtained from these inventions excited, in an intense degree, the skill and ingenuity of a host of able mechanicians in the various departments above mentioned. The most minute operations were reduced to system by the use of machines, and the high profits derived from manufacturing by machinery, while the prices of the articles continued the same as those formerly produced by manual labour, occasioned a readiness before unknown to adopt all new machines, as well as to extend and improve them.

Water-wheels.—The general introduction of self-acting machines induced the construction of more extensive mills of all kinds, and rendered necessary the use of more powerful and better regulated prime movers. Water-wheels were employed as the moving power at the early establishments of Cromford, Belper, Matlock, Bakewell. Lanark, Cattran, Deanstone, &c.; and when the governor was afterwards applied to water-wheels by Strutt, at Belper, the motion and power were regulated with a degree of uniformity almost equal to that of the steam-engine, and water was rendered as perfect a moving power as its nature admitted of. Rennie, it is believed, first applied the descending shuttle, by which the flow of water is regulated over its upper edge, so as to obtain the full benefit of the fall, instead of passing under the shuttle as formerly, whereby some of the fall is lost. He improved the construction of the wheel, increased the width and diminished the depth of the buckets, at the same time augmenting the velocity of the periphery from 3 feet to 5 feet per second. By these means nearly 75 per cent. of the power was realized. Strutt's improvements in water-wheels, executed by Hewes, consist in making them with slender iron arms and oblique tie rods, with segments of teeth on the circumference of the wheel, turning pinions with nearly the same velocity as cranks of steam-engines, and rendering them almost equally applicable. In this department Donkin and Fairbairn have also taken a conspicuous part.

The turbine, or a modification of the horizontal water-wheel, by Fourneyron, has latterly been introduced into this country from France, with, it is said, considerable success. The governor had been applied to windmills by Hooper, in 1789, and soon after Watt adapted it to his rotative steam-engine, which was thereby rendered applicable for turning mills, and its superiority to water, and every other power then known, became manifest. The uniformity and certainty of the movement, its capability of extension to any amount, its applicability to any situation, rendered its adoption almost universal, and extended the sphere of manufacturing operations from the weaver's cottage and the banks of the lonely stream, to large populous towns, such as Manchester, Leeds, Macclesfield, and other places, wherever circumstances, independent of water, were favourable for their adoption.

The concentration of manufacturing operations, caused a number of small machines to be substituted for those formerly impelled by hand in workmen's cottages, and brought together in large buildings adapted for that purpose, and worked by one great moving power, and so combined with each other and the building, as to render a spinning mill, with its water wheel, or steam engine, and all its accessories, one vast and complicated machine. A new school for mechanics was thus formed, in which far greater power than had ever before been applied to machinery, was to be distributed amongst a number of delicate machines of the greatest variety of form and complexity, with some parts minute like clock-work, requiring every gradation of force to drive them, and corresponding strength in some for resisting the largest and others the smallest impulse. A new and extended field of inquiry and observation was thereby produced, which brought forward artists of every description to contribute their aid, as to one common stock of knowledge, for the advancement of the new system of manufacturing, as well for the invention of new machines and processes, as for the multiplication and improvement of those previously invented. The ingenious and valuable labours of the great mechanicians of the last century have been most ably continued by their successors, many of whom are, or have been, our contemporaries, and who with a greatly extended sphere of application, have advanced in the career of improvement with an almost unparalleled rapidity.

Many new machines have been invented, and most of those in daily use have been rendered self-acting or automatical, so as to require no further aid from man, than the mere act of presenting the materials to them to be manufactured, directing their progress through the machine, and disposing of them afterwards.

The power loom, invented by Cartwright, in 1784, was afterwards improved by Austin, Miller, Horrocks, M'Adam, Lane, Bowman, and others, and its employment greatly extended. Machinery for making ropes and cordage, was invented by Cartwright, Grimshaw, Chapman, and others, and subsequently carried to great perfection by Huddart, as exhibited in the establishment of Turner, Huddart, and Co., at Limehouse. This ingenious and valuable invention consisted in regulating and adapting the lengths of the different yarns or threads composing the rope, so that each might bear an equal strain, which could not be done on the old system. To effect this, a series of bobbins, with the proper lengths of yarns wound upon them, were placed in a frame of a crescent form, and the yarns from these bobbins were conducted through holes in a vertical guiding plate, having those holes arranged in concentric circles; from thence the yarns passed through a vessel of liquid tar or pitch, and then through a single hole of the required gauge, on to a large reel mounted in an oblong frame, to which a rotatory motion about a horizontal axis, was communicated for twisting all the yarns together into a strand, and also a circular motion of the reel at right angles to that of the frame, for winding the strand upon the reel, as fast as they were wound off the bobbins; a guide was attached which regulated the winding. The whole was worked by one of Watt's steam engines. By this beautifully-contrived piece of mechanism, the whole of the yarns were twisted into a strand of the required dimensions. The pitch and tar employed was used either cold or warm, and derived the application of warm or cold register cordage accordingly. The cables were formed by a larger machine, combining three of the above-described frames together, each having one of the strands to form the cable wound upon its reel; but the axes of the three frames, instead of being horizontal, as in the first case, were vertical, and all mounted in one large frame, which received a rotatory motion, about a vertical axis of its own, and carrying round the minor frames combined within it in order to twist the three strands together. The several strands were unwound from the reels, in the minor frames, as fast as the three were twisted together into the intended cable, which was drawn upwards between pairs of grooved rollers, disposed above the centre of the main frame, and the cable was conducted away by the same machinery and coiled up for use. Nothing could be more striking than the spectacle of one of these magnificent machines, resembling a great orrery in motion, pursuing its silent yet resistless course, producing the means of securing at anchor the gigantic vessel of war against the raging tempests of the ocean. This magnificent machinery, after returning a handsome reward to its ingenious inventor, and the enterprising capitalists who erected it, was bought by Government, and erected at the Royal Arsenal, Deptford. Chapman's rope machinery, and Curr's for making flat ropes, chiefly used for mines, as well as a new machine, lately introduced at Portsmouth from France, said to be the invention of Hubert, are worthy of notice.

Dyer's machines for making cards, for cotton and wool, and others for cutting nails; Wilkinson's, for making weavers' reeds; the self-acting mules of Eaton, Roberts, Smith, and others; those for weaving bobbin-net lace, by Heathcoat, Morley, and others; Holdsworth's, Dyer's, and other improved machines for preparing cotton rovings; Marshall's, P. Fairbairn's, and other machines for flax, are all ingenious and important inventions of self-acting machinery, well calculated to improve, expedite, and economise the manufacture of the various articles for which they were intended. Amongst the same class may be mentioned the curious inventions and improvements of Didot, Donkin, Fourdrinier, Dickinson, Crompton, Towgood, Ibotson, Kœnig, Nicholson, Tilloch, Congreve, Stanhope, Cowper, Applegath, Spottiswood, and others, for making and drying paper, and printing by steam; Oldham's various contrivances for printing bank-notes at the banks of England and Ireland; Lowry's, Maudslay's, Perkins', and other machines for engraving on metal plates; Hollingdrake's method of casting copper under pressure, for engraving; Brunel's block machinery, executed by Maudslay, at Portsmouth, by which every operation is performed, from the sawing of the rough piece of wood until the perfect completion of the block for naval purposes; his saw mills at Chatham and Woolwich; Bramah's planing machine at Woolwich; Wilkinson's machine for boring large cylinders, are splendid specimens of machinery; neither must we omit Watt's simple operation of making small leaden shot, by pouring melted lead through holes in a cullender at the top of a lofty tower, when they assume a spherical form in cooling, as they fall through the air, and finally into cold water below. Leaden bullets are compressed into a spherical form with great solidity by self-acting machines by Napier. The manufacture of crown and plate glass, has been improved, and promises great extension; in this latter branch, Green, Pellatt, Chance, and others, are making great progress. The universal and widely extended application of machinery to every manufacturing operation rendered a corresponding activity and means of supplying the increased demand for it absolutely necessary; and additional means of making machines have been invented. Self-acting turning lathes, with slide rests, planing machines for metals, also for screwing bolts and nuts, were introduced by Fox; mortising machines, similar to those of Brunel, were adapted by Sharp and Roberts for metals, and shaping machines by Penn; these have been improved by Whitworth, Nasmyth, and others, by whom also new ones have been invented. The former has introduced an ingenious adaptation of machinery for sweeping roads and streets, and which, from its efficiency, is coming into general use; and to the latter we are indebted for the steam hammer and steam pile-driving machine, which serve materially to economise and facilitate these operations. Rennie, as far back as 1801, had applied steam for driving the piles of the coffer-dam for the London Docks; it has since been applied at Sunderland for a similar purpose, and he proposed it for working the cranes there as well as at the West India Docks; but it was not adopted. Otis' American machines for excavation have been tried, but are not as yet much employed. The invention and application of these various new and ingenious contrivances, furnished the means of executing machinery with a degree of economy and accuracy which, without them, could never have been attempted. With the advancement of machinery, the art of founding in iron, which commenced at Carron, soon became an indispensable part of machine making. In this department Boulton and Watt took the lead, in consequence of the demands for their steam engine, and made great improvements in it, which were afterwards followed by Maudslay (particularly), and by others. The working in metal towards the commencement of this century thus became so much facilitated, that it was generally adopted, instead of wood, for the framing and moving parts of machinery; and castings in iron, of excellent quality, could be obtained in any number exactly like each other, so as to be fitted together with great facility. In the progress of modern improvements, wrought or forged iron came into more general use, and was substituted for cast iron in many cases, such as for railways, suspension bridges, tie beams, and roofs for buildings; various parts of steam engines, mill-work, and machines of different kinds, and in some instances steel has been adopted. As the improvement in machinery for manufacturing advanced, so did the arrangement, convenience, economy, and construction of the buildings in which it was contained; fire-proof arching for floors, with cast-iron beams, wrought-iron ties, cast-iron columns, and wrought and cast-iron framing for roofs, window frames, and every other part where the introduction of metal was practicable; in these improvements, Strutt, Rennie, and others took a leading part. Apparatus for warming buildings by heated air was adopted by Strutt and Sylvester; and by steam, which had been employed by Smeaton, for drying gunpowder, was generally introduced by Snodgrass in 1798, and improved by Houldsworth and Creighton. This system has been more recently succeeded by that of heating the air by contact with pipes or vessels, in which a circulation is kept up, as practised by Price, Manby, Perkins, Haden, and others. These and many other improvements have been introduced, and combined in the most scientific manner in the great cotton-mills of Messrs. Phillips and Lee, M'Connell and Kennedy, Houldsworth, Birley, and numerous others at Manchester; Messrs. Horrocks' at Preston, Strutt's at Belper, the flax-mills of Marshall, and the woollen-mills of Messrs. Gott, at Leeds, and of Wilkins near Bath, the silk-mills of Grote at Yarmouth, the lace-manufactories of Heathcoat at Tiverton, Boden and Morley at Derby, and Fisher at Nottingham, Cartwright and Warner's steam power stocking-weaving manufactory at Loughborough, and many other magnificent establishments all over the kingdom. The workshops of Fox, Nasmyth, Sharpe, Roberts, Whitworth, and others, for making tools; the steam-engine and machine manufactories of Boulton and Watt, Fawcett, Bury, the Butterly Company, Stephenson, Hawthorn, Donkin, Hall, Fairbairn, Hick, Napier, Miller and Ravenhill, Maudslay and Field, Penn, Rennie, Seaward, &c., are a few of the vast establishments which abound, and which fill us with astonishment at the immense productive powers of this country; we are at a loss which to admire most, the genius and skill which has designed them, the energy and talent which directs them, or the capital which has brought them into operation. For accounts of many of the numerous branches of the immense manufacturing industry of Great Britain, we are indebted to Farey's articles in the Cyclopædia of Rees, the Encyclopædia of Brewster, and the Supplement to the Encyclopædia Britannica, also to those of Babbage and Barlow in the Encyclopædia Metropolitana, and likewise to Dr. Ure.

The improvement and extension of manufactures, required a constant, active, and steady communication between the several districts where they were carried on, and soon produced a corresponding improvement in the roads, railways, canals, rivers, and ports The cost of every article was reduced to the greatest nicety, and economy was carried to the minutest degree; being so intimately connected together, the extension of the one kept pace with the other. The same may be said of the arts of mining and metallurgy, by which coals for fuel and metals for manufactures are furnished to the different establishments.

Waterworks.—In the supply of that important necessary of life—water, which was so much studied by the ancients, but so greatly neglected in the middle ages, great progress has been made in modern times. Spring-water was formerly conveyed to public reservoirs in the City of London, by leaden pipes from various springs in the vicinity: viz., from Tyburn in 1236, from Highbury in 1438, from Hackney in 1535, from Hampstead in 1543, and from Hoxton in 1546. For these useful works, the citizens were indebted to the munificence of several Lord Mayors and other individuals, but those of Hampstead and Highgate are the only ones now remaining. The open watercourse or conduit from Dartmoor, 24 miles long, for supplying Plymouth with water, commenced by Sir Francis Drake, in the reign of Elizabeth, and the New River, for the supply of London, 39 miles long, 28 feet wide, and 4 feet deep, falling 3 inches in a mile, by Sir Hugh Middleton, in 1613, are considerable works of the kind, and were planned and executed at the cost of those distinguished individuals. Middleton was, in fact, ruined by it, and adopted the profession of an engineer and surveyor to obtain a livelihood.

London Bridge Waterworks, were commenced by Morice, in 1582, with water-wheels turned by the flood and ebb current of the Thames, passing through the purposely-contracted arches of Old London Bridge, and working pumps for the supply of water to the metropolis; it was the earliest example of public water service by pumps and mechanical power, which enabled water to be distributed in pipes to dwelling-houses. Previously, water had only been supplied to public cisterns, from whence it was conveyed, at great expense and inconvenience, in buckets and water-carts. In addition to the London Bridge and New River, several minor establishments of the same kind were afterwards erected on the banks of the Thames, to supply separate districts in their immediate vicinity. Some were worked by water-wheels on the sewers which discharged themselves into the Thames; others, by horses; and one by a wind-mill. That at Broken Wharf in 1594, at Shadwell and York Buildings, worked by horses, and at Chelsea by water-wheels, may be mentioned. Early in last century, when the old cisterns had nearly disappeared, and water was supplied to the dwellings, a great improvement took place, by the application of the steam-engine (which had then begun to develope its extraordinary powers) to the York Buildings Waterworks by Savery, in 1710, and afterwards by Newcomen in 1730. Newcomen's engines were subsequently applied at Chelsea, Shadwell, Stratford, London Bridge, and the New River Waterworks. As soon as Watt had brought his improvements into operation for pumping water, his engines were applied at each of the above waterworks by degrees, in addition to the old engines, thus a comparison between them could easily be made; and soon showed the superiority of Watt's engine in every respect. They were thus applied at Shadwell and Chelsea Waterworks in 1778, at London Bridge and Lambeth soon after, and at the York Buildings in 1804. The usual mode for the old engines was to pump the water into a cistern, at the top of a high tower, and from thence it descended through pipes, to the districts and buildings where it was required; the engine was thus always kept to its full load, whether necessary or not, and a waste of power ensued. Air-vessels were afterwards added to the pumps at Chelsea, and subsequently became general; the air in the vessels being compressed, acted by expansion and contraction on the water, so as to force it with regularity through the pipes, without going up to the cistern. Smeaton, who had constructed water-wheels for pumping at Stratford in 1763, and at London Bridge in 1767, where towers were employed, afterwards became the principal proprietor of the Deptford Waterworks, and in 1773 constructed a water-wheel for pumping water from the Ravensbourne without a tower. The machine is still in existence, although steam-engines have been subsequently applied. About 1810, Boulton and Watt's improved pumping-engines, constructed wholly of metal, and erected in handsome substantial buildings of brick and stone, with large air-vessels for pumping direct into the pipes, became generally adopted at all the London waterworks; cast iron pipes were substituted for the old ones of wood. The new engines being more powerful, and the cast-iron pipes stronger, enabled water to be distributed to cisterns on the tops of dwelling-houses, hence denominated the high service. Stone pipes were tried at the Grand Junction Waterworks, but failed, and iron pipes were substituted. Filtering reservoirs upon a large scale were constructed at Chelsea by Simpson in 1830, and subsequently at other places, with complete success, and are now universally employed. The water is now generally taken from the Thames above the town, where it is least adulterated. The old waterworks lower down the river, viz., York Buildings, London Bridge, the Borough, and Shadwell, have been abandoned, and new places chosen at Hammersmith and Brentford, higher up the river, and at Old Ford upon the river Lea; the river water is received into capacious settling, or filtering reservoirs, and distributed by steam-engines to the respective districts,. Latterly, powerful condensing steam-engines, very similar to Watt's, but worked by high-pressure steam with great expansive action, on the system introduced by Woolf, in Cornwall, for deep mines, were introduced by Wickstead, in 1840, at the East London Waterworks, and have since been adopted by other Companies with advantage in saving fuel. The double cylinder high-pressure condensing engine, with great expansive action, on the system of Hornblower, have also been introduced by Woolf, Hall, and Rennie, and applied to work mills with success. Waterworks, similar to those in the metropolis, have been erected at Edinburgh, Glasgow, Dublin, Manchester, Liverpool, and, all the principal towns in the kingdom. At Glasgow, one of the last engineering efforts of Watt, was to suggest the idea of laying a pipe under the Clyde, to bring water to the city from the opposite side of the river; this was to have been effected by making the pipe with flexible ball and socket joints, uniting the whole together in one piece, and closing it at each end, floating it to its position, and sinking it. Rennie effected a similar operation at York Buildings in 1810. The increased means for the supply of water, and the economy and punctuality with which it is distributed, has occasioned a greater consumption, and induced a degree of cleanliness throughout all classes, which has tended to augment the comfort and health of the community. Still the system is capable of improvement; larger reservoirs and more copious supplies are necessary.

Artesian wells, which appear to have been known to the ancients, and have been common in France and Italy, were introduced into this country about the year 1790, it is said, by Vulliamy, near London. The system consists in boring holes or wells through the superincumbent strata, impervious to water, until they reach the porous strata where water abounds, the pressure then acting according to the level from whence the water is derived, forces it upwards through the holes, frequently to some height above the surface; these have since been multiplied all over the kingdom during the present century, and latterly in Trafalgar-square, for supplying the first public fountains which have been erected in the metropolis. These fountains, though upon a small scale, are a beginning; and it may be hoped that this example will be generally followed for the ornament of this great city; which, although perhaps the best supplied with water in the world, has not been adorned with fountains, which are so general, and are constructed upon such a grand scale at Paris, Rome, and almost all the other great cities in Europe, adding so much to their magnificence and salubrity. In carrying out the improvements above mentioned for the supply of water, the names of Smeaton, Watt, Mylne, Rennie, Telford, Simpson, Bateman, Anderson, Clark, Wickstead, Walker, Martin, and others, must not be forgotten; and we shall no doubt witness efforts upon a still greater scale in future. Projects for bringing a large supply from the Thames, above Windsor, by Rennie; also from the Colne and Wandle, and Darenth, and elsewhere, by Telford, Rennie, and others, have long been in agitation, and sooner or later may be effected with advantage to the metropolis.

Sewage.—Connected with the supply of water for domestic purposes, we must not omit the important subject of sewage, or surface drainage, upon the due operation of which the health of the community so much depends. Sewers appear to have attracted notice at an early period, and during the reign of Henry VIII. commissioners were appointed with extensive powers to levy rates for, and to see them properly carried into effect; but until under ground or covered sewers were adopted, all the surface water from the adjacent hills and country, as well as the refuse from the buildings, was discharged into open ditches and street gutters, which, passing through the centre of the town, accumulated, and occasionally remaining stagnant for a considerable period, produced a degree of effluvia and malaria extremely prejudicial to the health of the inhabitants. This was remedied, to a certain extent, by covering over the open drains; but the bottom of these were not low enough, and the want of surface drains continued. By degrees, covered sewers, of enlarged capacity, entirely of brickwork, were introduced; the importance of the subject then became duly appreciated and studied; sewers were laid out upon a general and enlarged system; main, subsidiary, and surface drains, and cesspools of a proper form, construction, and capacity, adapted to each other, and to the several districts they were to drain, were designed, and, in many cases, carried into effect. The subject is still under consideration, and improvements are being daily effected, although much still remains to be done in the form, capacity, inclination, distribution, and arrangement of sewers, not only in the metropolis,* but in almost all the principal towns of the kingdom, before the system can be said to be complete. The removal of Old London-bridge, by which a fall of about 5 feet at low water has been gained, has been of immense advantage in improving the drainage of the metropolis; and it only remains for this great improvement to be carried out further, by removing the shoals and regulating the high and low-water channel of the river, by dredging and other means, but to be cautious in contracting the width; it is greatly to be desired that this important work should be speedily carried into effect, upon a general scientific system, which, if properly done, would confer the greatest benefits upon the extensive and populous districts, draining into and bordering upon the Thames, as well as the navigation of this noble river, upon the proper maintenance of which the immense commerce, health, and prosperity of this great metropolis, and its adjoining populous vicinity, depends. In the improvements of sewerage, Cubitt, Barry, Donaldson, Gwilt, Hardwick, Nash, Smirke, Soane, Walker, Rennie, Roe, and others, have been conspicuous.

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* There are nearly 500 miles of covered sewers in the metropolis.

Gas.—It is difficult to point out with accuracy the date of the invention and introduction of that invaluable substitute for daylight, or artificial lighting, carburetted hydrogen gas. It is generally believed, however, that it may be attributed to William Murdoch, soon after he succeeded to the management of Boulton and Watt's steam-engine works at Soho, although the inflammable properties of that gas had been long known. Murdoch's first apparatus was erected at Soho, and he successfully illuminated that establishment with it in 1802, in celebration of the Peace of Amiens; he afterwards constructed similar apparatus on a large scale at Leeds, for lighting Messrs Gotts' woollen manufactory, and for Messrs. Philips and Lee, at Manchester, and published an account of it in the "Philosophical Transactions" for 1808. Clegg, who was brought up at Soho, also published an account of it in the "Transactions of the Society of Arts" in the same year. It was subsequently, by degrees, introduced into several large manufactories in Lancashire; Winsor afterwards exhibited it in Pall Mall, where it excited a good deal of attention; but the general application of gas for lighting towns was for some time retarded, in consequence of the failure of several attempts by inexperienced persons, which prejudiced the public against it, so that it was not until the year 1813, that apparatus of efficient and proper construction was made, and erected in London by Clegg, Farey, and Manby, upon the same principle as originally introduced by Murdoch. The employment of gas for lighting towns and buildings has now become almost universal here as well as on the Continent. It is manufactured by distillation from coal in cast-iron or clay retorts, and collected in immense gasometers, some of them 100 feet diameter, 44 feet deep, and capable of containing 390,000 cubic feet; thence it is distributed through cast and wrought-iron pipes under properly regulated pressure many miles from the place where it is made; and self-acting meters, invented by Clegg, are applied at each building and district, in order to ascertain the amount consumed. It is purified by lime, sulphuric acid, &c., and its brilliancy is augmented by naptha. In the various contrivances and details of the apparatus, and in the processes for manufacturing it, as well as in the economy of management, many improvements have been made by Clegg, Lowe, Manby, Philipps, Croll, Crosly, Hedley, Edge, and others. When we compare the present mode of lighting towns and public buildings with gas, with the old system of oil lighting thirty years ago (even allowing that to have been a vast improvement upon the custom of our ancestors), we are astonished at the amelioration, and can scarcely comprehend how we could have gone on so long without it. Thus we find that the general adoption of every great improvement creates a refinement and fastidiousness of taste which stimulates others, so that we can no longer tolerate those imperfections which in a less advanced state of civilization were passed over unnoticed. The introduction of oil gas by John Taylor, and by Taylor and Martineau; Gordon's system of condensing gas into close vessels for rendering it portable; and resin gas by Daniell, must not be forgotten, on account of the superior light produced from those substances, although it has been superseded by the more economical coal gas, and when napthalized on Lowe's plan, its light appears so pure as scarcely to be susceptible of improvement. Gas for lighting on an extensive scale was introduced into France by Manby in 1820, and has since become general on the Continent. The use of gas-light in private dwelling-houses is gradually extending, and as the objections of smoke, bad smell, and risk of explosion are fast disappearing before the exertions of the modern improvers, will become more general; the ingenious contrivance of Faraday, conveying away by pipes all the products of combustion, is worthy of notice. Clark and M'Neil's, and other burners, which insure more perfect combustion, are decided improvements.

The employment of gas for Lighthouses promises important results; for there, almost any reasonable degree of cost and trouble in perfecting the light, so that it may be rendered more distinctly visible at greater distances at sea, will be amply repaid; in this class may be mentioned with praise the oxy-hydrogen light of Drummond, and the Bude light by Gurney. Latterly the catoptric and dioptric system of Fresnel, which consists in an ingenious and scientific construction of the lenses, and an adaptation of the compound argand burners to suit them, has been introduced into several of our light-houses with advantage, but further experience is necessary to decide which is the best, the system of Fresnel above mentioned, or the old argand system with the parabolic polished silver reflectors; both plans have been well executed by Wilkins and by Deville.

In the construction of Lighthouses since Smeaton, Messrs. Stevenson's and Walker have done much, and recently Gordon's cast-iron Lighthouses appear, for certain situations, to merit attention.

Roads.—In proportion as the wealth and commerce of the country increased in the latter half of the last century, so it became absolutely necessary to improve the communication by roads and wheel-carriages, between all the different towns and districts of the empire, for supplying them with provisions, fuel, and the necessaries and luxuries of life, with greater facility and economy, as well as for expediting commercial and general intercourse, in fact, the one followed as the necessary consequence of the other, and the public seeing and feeling the beneficial effects of what had been effected, and convinced of the practicability and advantage of proceeding further in the cause of improvement, would not rest satisfied until those improvements were made; accordingly, the improvements of roads attracted general attention. Originally, roads were mere footpaths, or horse tracks across the country, in the most convenient and shortest direction between the desired places, but wholly unadapted for wheeled carriages; by degrees they became practicable for the rude carriages of the times, and they were maintained in a very defective state by local taxes on the counties or parishes in which they were situated, nevertheless, nothing in the way of effectual improvement was attempted, until turnpike trusts were established by law, for raising or levying tolls or taxes from persons travelling upon the roads. Several Acts of Parliament for these trusts were passed previous to 1765, but in the early part of the reign of George III. many more were passed, notwithstanding violent opposition was made to the tolls. They subsequently became general, and penalties were recoverable at common law, against the trustees, for not keeping the roads in proper repair; a long period, however, elapsed before any good system of road-making was established. The old crooked horse tracks were generally followed, with a few deviations to render them easy; the deep ruts were filled with any materials which could be obtained nearest at hand, and were thrown upon them in irregular masses, and roughly spread to make them passable: the best of these roads would in our time be declared intolerable. Road-making as a profession was unknown, and scarcely dreamt of, and the parties employed to make and keep the roads in repair were ignorant and incompetent to do their duties; but inasmuch as travelling was uncommon, and the funds at the command of the trustees were scanty, we cannot be much surprised at it, as they could not command higher talent. Engineers, except in cases of great difficulty, such as making a bridge over a deep and rapid river, cutting through a hill, or embanking across a valley, where more than ordinary skill was required, considered road-making beneath their consideration, and it was even thought singular, that Smeaton should have condescended to make a road across the valley of the Trent, between Markham and Newark, in 1768. The great activity and prosperity, however, which resulted from the modern manufacturing system, convinced people of the value of time, and that easier and more rapid means of communication than the old roads permitted were required; hence, the acclivities were partially reduced by cutting down the hills and raising the intervening valleys; improved bridges were built with easier ascents, and in some cases cuts were made to shorten the distance; still, however, the general line of the old road was preserved. The roads were certainly improved by this means, but still there was no general system; they were parcelled out into small districts under separate trustees, without any common concert or harmony in working together, and but little effectual progress was made. The importance of forming good roads was but imperfectly understood, the legislation connected with it was equally short-sighted, and many of the improvements in cutting down hills, and levelling valleys were frequently repeated, from want of proper skill and foresight at first. The rebellions in Scotland, in 1715 and 1745, induced the Government of that day to turn their attention to the subject, and several roads were constructed by military engineers for military purposes.

Telford, previous to his being employed to construct the Caledonian Canal, had turned his attention to road-making, and was appointed by the Government to lay out new lines of road, both for the purpose of employing the then poor and thinly scattered population of the Highlands, as well as to improve the districts by more general intercourse with the rest of the kingdom; he evinced a skill and knowledge which had not hitherto been bestowed on this important subject, but which was afterwards developed upon a greater scale in Ireland, and lastly in England, in his great works, the Holyhead, Liverpool, and Great North Roads, formed in consequence of the increased communication with Ireland after the Union, and which were excellent models for roads throughout the Kingdom. Telford set out the roads according to the wants of the district through which they were made, as well as with a view to more distant communication, and the acclivities were so laid out, that horses could work with the greatest effect for drawing carriages at rapid rates. The road was formed by a substratum of large stones, with sufficient interstices between them for drainage; the materials laid on this foundation were hard and angular, broken into small pieces, decreasing in size towards the top, until they formed a fine hard surface, whereon the carriage-wheels could run with as little resistance as possible. The transverse section of the road had no greater convexity or rise, than was sufficient to cause the water to run readily into the side-drainage channels: by this means, the carriages not being inclined laterally, the weight was more equally divided on the wheels, whereby they moved more easily and with the least wear and tear of the roads. The surface of the road was always kept even and clean, by the addition of proper fresh materials where necessary, and distributed equally in thin layers immediately after rain, in order that the new materials might bind and incorporate properly with the old. Telford's system was afterwards extended by his assistant, Macneill, and is fully described by our late honorary member, Sir Henry Parnell, afterwards Lord Congleton, who, by his perseverance and support of Telford, mainly contributed to its extension and success. About the year 1816, M'Adam iutroduced his system, and brought it into general use in the vicinity of Bristol. It resembled in some respects that of Telford, but differing from it by making no foundation in the first instance; it consisted in simply laying a stratum of flints, or other hard materials, 10 or 11 inches thick, broken equally into small pieces about 2 inches diameter, and spread equally over the intended road; this soon became so consolidated together by carriages passing over it, that they could travel with great facility and expedition. The section and the mode of applying fresh materials and keeping it clean, resembled that of Telford. M'Adam, professing to be a road-maker only, devoted his whole time and attention to the propagation of his system, which was greatly superior to the old, and became very generally adopted. Its introduction and extension was in a great degree due to our honorary member, the Earl of Lonsdale, who is ever alive to improvement; and to his Lordship's exertions we are indebted for the present system of metropolitan roads, which has proved of great advantage to the public.

The great improvement in roads, which was accompanied by a corresponding improvement in the carriages and breed of horses, produced an extent of travelling commensurate with the increased facilities afforded. Coaches were first introduced into England in 1580, about the time of Elizabeth. Public, or hackney-coaches, were only established in London in 1625; and stage or public travelling coaches, not until a much later period: in fact there were few roads upon which they could pass; and for fear of being robbed by highwaymen, or of being overturned or stuck fast in the mire, and other accidents of the road, they seldom or ever travelled during the night. In 1666, (the year of the Fire of London) a coach was established, which travelled between London and Oxford in two days; and another, called the Flying Coach, afterwards started to perform the journey in thirteen successive hours, or at the rate of 4 miles an hour, but only ran during the summer months. The journey between London and Edinburgh by stage coach, which was begun in 1712, took thirteen days to perform the journey: in fact, so great was the difficulty and danger of travelling, that, before setting out upon a long journey, people made their wills, as if they never expected to reach their homes again. After the roads had become sufficiently improved, mail-coaches, upon an improved construction, to carry passengers and letters, were first introduced by Palmer in 1784, and the journey between London and Edinburgh was reduced to three days and nights by this conveyance. At the first appearance of this extraordinary novelty, the inhabitants of the rural districts crowded the roadside to see the royal vehicle, with its gaily-appareled horses and scarlet liveried coachmen and guards, galloping by at the accelerated speed of 7 or 8 miles an hour; but, when it was increased to 10 and 11 miles an hour, by further improvements in the roads, carriages, and axles, by Vidler, Collinge, and others, ameliorating the breed of horses, and shortening the stages, and the distance between London and Edinburgh was performed in 42 hours, it was considered that this could not be exceeded—and so far it was true; for animal strength and endurance had reached its utmost limits, and, if any improvement was to be obtained, it was requisite to obtain it from a different source. In the race of improvement, the stage coaches were not behind the mails; and we have only to mention the Brighton, Oxford, Cambridge, Southampton, Shrewsbury, and other coaches, to prove that the system was carried to the highest degree of perfection of which it was capable.* In 1821 there were 24,581 miles of turnpike roads in England and Scotland, and 8000 miles in Ireland; and since that time they have much increased.

Paving.—When the turnpike-road system was introduced, the pavement of the metropolis was improved by the substitution of square blocks of granite, in place of the rounded boulders, or large irregular pebbles, which had been previously used. Blocks of granite of various dimensions, have, by way of experiment, been laid on concrete, with the joints grouted with lime and sand, in order to insure the greatest stability amongst the blocks. M'Adam's system was introduced in some streets where the traffic was light, but it did not equal the granite paving. Wood blocks in different forms, hexagonal prisms, or cubes, or rhomboids, with the grain placed vertically, or nearly so, have been introduced for paving, the blocks being either connected by wooden pegs, or merely laid upon a bed of concrete. This system was borrowed from Russia, and patents have been taken out by Stead, in 1839, and many others, for different forms of the blocks; it has the advantage of diminished noise and friction, but its great defect is that of being dangerously slippery in particular states of damp weather, and it appears in consequence likely to be abandoned. Asphalte, a natural brittle, bituminous substance, found in volcanic districts, was introduced from France for foot pavements, in 1836; it is brought to a semi-liquid state by heat, then mixed with sand and gravel, and spread over a bed of concrete, and when cold, forms a compact and durable pavement. Flags, or flat gritstone paving blocks, have been used in larger blocks, and better laid, so that paving has been much improved; the great difficulty, however, in keeping it in order in London and great towns, is occasioned by its being constantly broken up, to lay and repair the numerous gas and water-pipes; and it is desirable that separate tunnels or subways should be employed for receiving them, as was suggested by Williams and others a few years since.

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* The transport of goods was equally defective as to speed, and was comparatively as costly as that of passengers; at times goods were from four to five weeks, and seldom less than thirty-six hours in going from Liverpool to Manchester, at a cost of forty shillings per ton; whereas at present they are conveyed in three or four hours, for three shillings per ton.

Railways.—Whilst the turnpike road and coach system was rapidly advancing towards perfection, numerous active and inventive spirits, aspiring after better things, were busily employed in racking their brains to invent a mode of travelling, or locomotion, which should far exceed its predecessors; great difficulties however presented themselves—and amongst the agents which were thought of none appeared so well adapted for the object as steam, the success of which, in the hands of Watt and others, had proved so triumphant, wherever it had been applied; but, in order to attain the wished-for velocity, a different kind of road was required to that which had hitherto been used: and at length the railway system was introduced.

Railways, formed with wooden rails, or parallel pieces of wood, with carriages having wooden wheels to run upon them, had been in use at Newcastle as far back as 1681, for the purpose of conveying coal down from the mines to shipping-places on the banks of the Tyne; Labelye, in 1743, described improved carriages, used by Allen in stone quarries at Bath, having wheels with flanges of cast-iron, adapted to run on wooden edge-rails; being an improvement upon those at Newcastle; afterwards, the wooden rails were plated with iron, which made the carriages run more easily with a greater load; cast-iron rails, or plates, were brought into use for the first time by Reynolds of Colebrook Dale in 1767; and more completely by Curr at Sheffield, with waggons having cast-iron wheels without flanges, the rails being in the form of tram plates; and in 1769 Edgeworth introduced three or four waggons drawn in a train, by one horse. These iron tramways, laid upon stone blocks, with the carriages above described, having smooth-tired wheels without flanges, came into general use, for drawing coals, stone, and other minerals, from the mines and quarries underground, and at short distances from canals; but no lines of any great length were made for general traffic. The first line of any extent, it is believed, was that at Loughborough, by Jessop, in 1789; also between Cardiff and Merthyr Tydvil, the Act for which was obtained in 1794; this was followed by the Croydon and Surrey Railway between Wandsworth and Merstham, in 1804: for the periods, all these were considerable works of the kind. About this time railways were used by the contractors during the execution of great works, at the London, the East, the West India Docks, and other places, where the transport of vast masses of materials was required; when the works were completed, the rails or plates, which were made with side flanges to keep the wheels in their places, were generally sold, and were occasionally used for constructing short lines to canals and shipping-places. The only power applied to draw the waggons was that of horses. These railways were considered inferior to canals, and were seldom used, except when the traffic was chiefly descending, so that the empty waggons could return with facility. The application of steam power to the propulsion of carriages might, it would seem, have naturally commenced with carriages on the common roads; but so many difficulties intervened, that the attempt was not made until after it had been effected on railways. Dr. Robison proposed it to Watt in 1769, and Darwin mentions it in 1796; but the application of Newcomen's or Watt's engines, for propelling carriages, could not be attempted with any probability of success, as they required copious and constant supplies of cold water for condensing the steam, which would have rendered the machine so cumbersome and unwieldy as to be unmanageable. Watt's practice was to condense the steam at a comparatively low temperature: for although he tried it in almost every state, from high to low pressure, he ultimately, under all circumstances, preferred employing steam at about 3 lbs. above the pressure of the atmosphere. Amongst his earliest investigations he made a model of a high-pressure engine, which acted very well; and he described a high-pressure locomotive engine in his specification of 1784; but he considered steam at such a high pressure to be unsafe, and did not make any use of it. His assistant, Murdoch, afterwards, made a working model of a locomotive engine which acted very well, but he did not pursue it further. Leupold had proposed a high-pressure engine in 1725; and one was made by Cugnot at Paris in 1770 for propelling a carriage, but it failed entirely, and was never used.

Trevithick and Vivian obtained a patent in 1802, for high-pressure engines, in one of which locomotion was to be produced by the adhesion of the wheels, propelled by the engine working on the road. They also proposed ribbed wheels with nails or bosses, for the purpose of enabling the engine to ascend steep places. In 1804 they made a locomotive engine, which travelled upon the Merthyr Tydfil Railway; it consisted of one high-pressure cylinder, with a fly-wheel, and four bearing-wheels, two of which were turned by the action of the piston, and produced a velocity of five miles an hour, drawing after it several waggons, containing a load of about 15 tons. This locomotive worked by adhesion alone. The experiment was not continued, because the weight of the engine, with its cast-iron boiler, was considered too great for the rails, and might have occasioned considerable damage to them, and if the weight of the engine had been reduced sufficiently, it would have been too light, and the wheels would have slipped upon the rails. Thus we see, that the great principle of adhesion, for producing locomotion, was clearly understood at the outset, and was only abandoned in consequence of the cast-iron plate rails at that time in use, being unfit for carrying it into effect. In addition to the objection on the score of the weight of Trevithick's locomotives, more serious opposition arose against them in consequence of one of them having exploded in 1803. This objection was made to all Trevithick's locomotive engines, although ultimately they came into use. He had made an attempt to propel carriages on common roads by steam in 1806, and constructed a carriage worked by steam, which was exhibited publicly, in [the neighbourhood of Bethlehem Hospital. To that ingenious and able man the origin of the locomotive system may be said to be due. In 1811 Blenkinsop took out a patent for using rails, having teeth like a rack in them, into which wheels, having corresponding teeth, were worked by the engine, thus securing the engine against the chance of slipping. This was brought into use for conveying coals from the Middleton Colliery, near Leeds, which may be said to have been the first practical employment of locomotive engines; but the expense, friction, noise, and slowness of the motion, which scarcely exceeded four to five miles an hour, prevented it from being generally adopted. In 1813 Brunton took out a patent for producing locomotion by levers, worked by the engine, resembling a good deal the motion of a horse. This however failed, and a serious accident occurred by the explosion of the engine attached to it. Chapman followed, and patented an invention for producing locomotion by means of chains laid along the line of road, passing round the wheels of the locomotive, and thus travelled forward. In 1813 Blackett resumed Trevithick's original plan, and constructed an engine which worked by adhesion alone, upon the rails at the Wylam Colliery at Newcastle.

George Stephenson in 1814 improved upon all the former locomotives, and took out patents in conjunction with George Dodd in 1815, and with Losh in 1816. The locomotive, in his hands, soon became sufficiently perfect to be brought into general use on railways, for drawing coal-waggons at a greater rate than could be performed by horses. The weight of the engine was sustained on the axles of the carriages, by means of small pistons working in cylinders, supplied with water from the boiler, which acted like so many springs. Two steam cylinders were employed, and all the four wheels were impelled by them; the engine was followed by a tender carrying water and fuel. Here was a grand epoch in the history of railways, which were destined at no very distant period to effect such a complete revolution in the whole system of international communication, and to realise such extraordinary results, as even the most sanguine minds never anticipated. James, who had examined the machines, published a letter in 1815, proposing railways as a general system for travelling. The general introduction, in 1816, of the cast-iron edge rails, and the flanged wheels, which are said to have been invented by W. Jessop, long before, on the Loughborough Railway, instead of the cast-iron tram-plates with which the earlier railways had been laid, was soon followed by the introduction of wrought-iron rails, in long pieces, at first, in plain rolled bars, and afterwards rolled with projections on their upper edges, in order to give breadth for the wheels to run upon, as well as to increase the strength of the rails and enable them to bear greater weights without yielding. This was the patent invention of Birkenshaw, who made them in 1820. The above were great improvements in the system, and by degrees, all the details were worked out more effectually at the different collieries near Newcastle, and in the North, until the locomotives were so far improved, as to enable them to travel at the rate of seven to eight miles per hour, drawing considerable loads behind them. The Hetton and the Stockton and Darlington Railways, by Stephenson, which were opened about 1825, contained all the improvements made up to that time; and the last Act of Parliament of the latter line authorized the use of locomotive engines.

The Liverpool and Manchester Railway Company obtained their first Act in 1826, under the Messrs. Rennie, but the kind of tractive power to be employed was left open for future determination. The railway works, however, proceeded, and considerable progress was made before it was decided what power should be employed. The Company employed Messrs. Walker and Rastrick to investigate the different means employed in the North as tractive power on railways, and to report which, in their opinion, they considered best adapted for the railway; upon the whole, they reported in favour of using stationary engines to draw the waggons and carriages. Stephenson and Rennie were in favour of locomotive power. The directors took up the matter with considerable spirit, and offered a reward of five hundred guineas for the best locomotive engine. The competitors for this premium were, Stephenson, Braithwaite and Ericson, and Hackworth and Brandreth. The weight of the engines was restricted to 6 tons, including the water in the boiler, and the load was limited to three times that weight, to be conveyed at the rate of at least 10 miles an hour. A trial of the engines of three competitors was made on a portion of the Manchester and Liverpool Railway, in 1829, and the extraordinary speed of between 20 and 30 miles an hour was realized by Stephenson's engine 'Rocket.' So long as the motion upon the rails was produced by the rack and pinion, the greatest velocity attained scarcely exceeded 4 or 5 miles an hour; this was only adapted for the transport of heavy goods, and the expense, except in few situations, precluded it from being extensively brought into use; but the principle of adhesion being established, and 7 and 8 miles an hour obtained, the success of this great invention became evident, and it was predicted that its adoption would become general. Still, however, doubt and prejudice prevailed with many, and amongst them were some men of no ordinary ability and experience, and it was not until the triumphant success of the great experiment in 1829, that the most sceptical were convinced of the application of the system eventually becoming universal. The scientific world beheld with amazement this extraordinary result, the consequences of which could hardly be foreseen. Springing at once from a velocity of travelling of 10 miles, the greatest speed of coaches, to 25 miles an hour, so far exceeded even the most sanguine expectations of its promoters, that they saw no bounds to its extension.

Stephenson's engine for the competition was upon an improved plan; the boiler contained numerous small tubes, through which the flame, or rather heat, from the fire-box or furnace, was made to pass, thus exposing a greater surface of water for the heat to act upon, and increasing its powers of evaporation. Booth, the indefatigable secretary to the Company, has the credit of this great improvement, which is now universally adopted, not only in locomotive, but also in marine boilers. The engine had two cylinders which impelled the wheels, and the waste steam from the cylinder was discharged through a small tube or blast-pipe into the chimney, with a vertical jet, thus increasing the draught of the fire, and enabling it to produce the desired heat in the fire-box. This blast-pipe was a most simple, ingenious, and important invention, which has contributed very materially to the improvement and perfection of the locomotive. The merit of this is claimed by both Stephenson and Hackworth. The boiler and apparatus were supported on the frame by springs, in the same manner as in ordinary wheeled carriages, thus preventing the concussion to which the different parts would otherwise have been subject, and enabled the machine to work with greater effect. The 'Novelty,' by Braithwaite and Ericson, was also a very ingeniously contrived engine. The 'Sans Pareil,' by Hackworth, was an improvement upon previous engines, but did not fulfil the conditions required so well as that of Stephenson, to whom the premium was awarded. Looking back at the result of these experiments, and what has occurred since, it appears injudicious that the weight and size of the engines should have been thus limited; for inasmuch as the power of traction of a locomotive engine depends upon the force of adhesion, which could only be produced by weight, and its capability of generating steam by increased dimensions, by limiting these two elements the power of the engine was necessarily reduced. Upon reflection, however, we cannot be surprised, for nothing but experience could have pointed out beforehand the present extraordinary results.

The Manchester and Liverpool Railway was opened in September, 1830, with great ceremony by the Duke of Wellington, Sir Robert Peel, Mr. Huskisson, and an immense concourse of spectators; but unfortunately this great event in the mechanical, commercial, and social world was clouded by the death of that great man, Huskisson, in consequence of a locomotive engine passing over him, thus becoming one of the first victims of that extraordinary invention, of which he entertained so high an opinion. The first engines for this line were made by Stephenson, after the plan of the 'Rocket,' but improved; and in other engines made soon after, he introduced a better arrangement of the parts, giving a greater number of tubes to the boiler, and adapting cranked axles to work the wheels; the first of these was the 'Planet,' which afterwards served as a model for the locomotives on other railways. Great improvements have since been made; heavier engines, weighing from 18 to 30 tons, capable of evaporating 200 to 300 cubic feet of water per hour, instead of 60 cubic feet, as in the early engines, with tenders capable of carrying 1000 to 1500 gallons of water; straight axles, with outside cylinders, like those of the 'Rocket,' have been again introduced, in order to increase the power and to obviate the objections raised against the cranked axles, as to their liability to break; engines, with six wheels instead of four are now generally approved, as being safer; and those with coupled wheels have been made to increase the adhesion on steep planes. Improvements in the slide valves and working gear have been made for using the steam expansively in the cylinders, and rendering the engines more manageable either for backward or forward movement. The increased size and power of the engines have enabled them to ascend planes of 1 in 37, as on the Gloucester and Birmingham Railway, drawing after them heavy loads at considerable velocities, which, at the first introduction of the locomotive, would have been impossible. On that line, at the Lickey incline, engines made in America were at first used.

The mode of making and laying the rails of the permanent way has also partaken of the improvements in the engines; the original rails of the Manchester and Liverpool line weighed only 30 lbs. per yard, of the form termed ‘Fish-bellied,’ and, for the most part, were laid upon stone blocks, after the plan of the colliery railways, on which the speed rarely exceeded 2 to 5 miles per hour, but when it was increased to 20 or 30 miles per hour, greater strength was necessary. The concussion produced by such heavy engines and trains, weighing from 50 to 300 tons, travelling at the rate of 20 miles and upwards per hour, soon deranged the light rails, and the concussion produced by the stone blocks rendered the employment of some more elastic medium, desirable. Accordingly, heavier rails, parallel in depth, with a rib at top and bottom, were adopted, after the form suggested by the experiments of Professor Barlow, with as much weight as the art of rolling iron could give, until it reached 75 lbs. per yard; instead of stone blocks wooden sleepers have been preferred; heavier and improved chairs for supporting the rails, with side keys of hard compressed wood to keep them in their places and resist the concussion, have been adopted; in this latter department Ransome and May have introduced great changes; the sleepers have been steeped in preparations from the patents of Burnet, Kyan, and Bethell, for the purpose of securing greater durability. A variety of plans for making the rails and laying the permanent way on improved methods, have been proposed and tried, such as the bridge or hollow rail screwed down to longitudinal sleepers, which again are screwed to transverse sleepers below them, as adopted on the Great Western Railway; the solid rail secured by screws to longitudinal sleepers alone, as adopted on the Greenwich and Croydon lines; the parallel rail fixed to transverse sleepers, as adopted on the Dublin and Drogheda line, and others, all of which require the test of experience before any correct opinion can be formed as to their respective merits.

Rails of prepared wood, patented by Prosser, have been proposed for ensuring the adhesion of the wheels on steep inclines, but have not been much adopted.

Stone railways or trams, which have been in use in the streets of Milan for a long period with considerable advantage, were employed at the Dartmoor Railway, to bring down granite from Dartmouth to Plymouth, a distance of 20 miles; also one of 12 miles in length for a similar purpose from Haytor to Newton; and a more perfect example was completed by Walker between the West India Docks and London, on the Commercial Road, a distance of 2 miles, in 1826. The tramway is composed of blocks of granite, 4 to 5 feet long, 16 inches wide, and 12 inches deep, nicely squared, bedded, and jointed, and laid in a bed of concrete; it has been found of considerable service in reducing the friction, and enabling horses to draw heavier loads with facility, in ordinary cases.

In addition to the adoption of wooden sleepers, it has in some cases, where great speed is employed, been considered advisable to introduce a layer of india-rubber, or elastic felt, between the rail or chair and the sleeper, in order still further to reduce the concussion, and to render the motion more easy; for now that the extraordinary speeds of 40 to 50 miles per hour have been effected, and are daily employed on the Great Western and other railways, too much care cannot be taken in constructing the works of the railway, and particularly in laying the permanent way; and until this be done it is scarcely prudent to exceed the present high velocities.

Before leaving this subject, it may perhaps be necessary to make a few remarks upon the width of gauge. This important question comprehends so many elements, that the determination of it is involved in considerable difficulty, and experience alone can afford it satisfactorily. Stephenson, who has taken such a prominent part in the introduction and extension of the railway system, adopted the gauge of 4 feet 8½ inches. Messrs. Rennie proposed 5 feet for the Manchester and Liverpool Railway before it was commenced; this, contrary to their advice, was afterwards made 4 feet 8½ inches. Brunel proposed, and carried into effect, 7 feet on the Great Western. The Eastern Counties was originally laid at 5 feet 6 inches, and afterwards altered to 4 feet 8½ inches. The Dublin and Drogheda is 5 feet 3 inches; and the Ulster lines are laid at 5 feet 6 inches. Cubitt now proposes an uniform width of 6 feet throughout the kingdom; the object of all being to ensure the greatest perfection in the engine; as to speed, power of traction, economy of working, and safety in transferring passengers and goods. Taken in the abstract, a broad gauge would appear to afford the means of making more powerful engines, which can draw greater loads with greater speed and safety than a narrower gauge; but then it involves a greater first outlay, and a commercial question arises, is this necessary, when already, upon the narrow gauge, a speed of 60 miles an hour has been obtained with a tolerable load? A greater velocity appears not to be advisable, until the mode of making the road has been improved, and in the mining and manufacturing districts, the narrow gauge is stated to be more convenient and less expensive. Uniformity of gauge, however, is generally admitted to be desirable, in order to avoid the delay, expense and inconvenience of a change of carriage for both passengers and goods, and it is to be regretted that a broader gauge had not been adopted on the Manchester and Liverpool Railway, which might have served as an example to all subsequent lines, and have prevented the difference of opinion which has since prevailed. The gauge of the Great Western is probably greater than is necessary; but as it has already been adopted to a considerable extent, and has certainly realised very extraordinary results, and as it is impossible to foresee what further improvements may result, so as to obviate any inconvenience arising from a break of gauge, it would seem not to be desirable to stop the progress of improvement by altering it now, when it may be the means of creating further improvements in itself, as well as in the narrow-gauge system, which might otherwise never be thought of.

The traffic on the Manchester and Liverpool Railway far exceeded the most sanguine expectations, and the passenger traffic, which was scarcely reckoned upon as a source of revenue (goods alone being relied upon), increased to such a degree, that it soon superseded every other conveyance between Liverpool and Manchester, and produced a large additional revenue. Notwithstanding, however, its brilliant success, the great cost of the railway, and the remnants of old prejudices against innovation, combined to keep alive the doubts and fears as to the profits which might be expected from other railways, less favourably situated than between two such large manufacturing and commercial towns, depending so entirely upon each other. Hence the numerous projects which were first brought forward met with a great deal of opposition, and did not receive that encouragement which subsequent experience has proved them to be entitled to.

After much delay, several Acts of Parliament for new lines of railway were obtained, notwithstanding the most strenuous opposition of the existing interests of canals, roads, land-owners, &c., which was only overcome at enormous costs. Amongst the first of these may be mentioned the London and Birmingham, the Grand Junction, the Great Western, Bristol and Exeter, Southampton, Brighton, Dover, Leeds, York, and others. The prejudices against them have now vanished, and the mania for new lines has of late exceeded all former precedent. 1901 miles have been already executed on the narrow gauge, 274 on the broad gauge: 614 miles are in progress of construction, and projects for 20,687 miles were actually introduced into Parliament last session, representing a capital of £350,000,000. Of these projects, Acts of Parliament have been passed for 3573 miles, requiring a capital of £129,229,767.

In most parts of Europe, railways have already been constructed, or are in progress, or in contemplation, after the plan of those executed in this country. The following names must be borne in mind as associated with the invention and propagation of the railway system,—Barnes, Birkenshaw, Bidder, Blenkensop, Blackett, Booth, Brandreth, Braithwaite, Brunel, Buck, Buddle, Cubitt, Curr, Dodd, Ericson, Giles, Good, Hackworth, James, Jessop, Leather, Losh, Locke, Lambourt, M'Neil, Rastrick, G. and J. Rennie, Reynolds, G. and R. Stephenson, Trevethick, Vignoles, Vivian, Watt, Walker, Wood, and many others.

Steam Coaches.—Great efforts have been made to perfect steam-coaches, so as to enable them to travel upon turnpike roads, but hitherto without much success. The idea was suggested by Robison to Watt, in 1759, and Watt patented it in 1784. Symington proposed it in 1786. Trevithick's patent of 1802 was the first high-pressure engine that was actually made, and patents for improvements upon it have been numerous. Bramah constructed a steam-coach in 1822 for Griffiths, which was not successful. Gordon tried one in 1824, and Gurney, who was more successful, constructed some with boilers, having very small tubes; he attained a speed of 10 miles an hour on good turnpike roads, and ascended the steepest hills near London; he went from London to Bath and back, in 1831, and his steam-carriages ran for four months between Cheltenham and Gloucester; but it was extremely difficult, and too expensive, to keep them in order. Hancock constructed several with boilers composed of thin metal chambers; they ran for some time, with apparent success; but there were so many difficulties that they did not get into use. Dance, Field, Hill, Macerone, Russell, Cayley, and others, also attempted it with varied success; but the system is inferior to that of railway travelling, and it is now generally given up as hopeless. It has been proposed to employ highly compressed air in place of steam for propelling locomotive engines, first by Medhurst, in 1799, and since by others, but without any trials being made beyond mere models.

Fast Canal Boats.—Attempts were made by Grahame, and others, to accelerate the passage-boats on canals; the mode was extremely ingenious, and at one time was brought into use on the canals in Scotland, the north of England, and other places. The mode was as follows:—A beautifully-constructed boat, whose length was about ten times as great as the breadth, and drawing very little water, was drawn by two horses, commencing at a trot, and soon increasing their pace to a gallop; the boat once put in motion required very little effort to maintain its speed, which was 10 miles an hour, and formed a considerable improvement in canal navigation; increased expedition was also given to the boats for goods, and general speed and economy of charges and improvement in management prevailed. All this, however, came too late, for although it would have been readily acknowledged at an earlier period, and might perhaps, for a while, have retarded the railway system, yet when once the latter was established, its superiority became manifest, and its progress became irresistible. The railway system also gave increased stimulus to improvement in steam-boats, which had been previously in use, and which I shall presently notice more at length.

Taken simply at the velocity of 2½ miles per hour, the resistance or friction offered to the tractive power by a given load is in favour of the canal; but as this resistance increases with the velocity at a far greater ratio on the canal than on the railway, the advantage with increased velocity becomes decidedly in favour of the railway, and inasmuch as the value of time in everything has become more important, so railways must necessarily increase in superiority; besides, as in any case having a large profitable traffic in passengers, which a canal cannot have, the extra power for conveying goods is comparatively very little, so that the competition even in heavy goods, in many cases, is in favour of the railway also. Some canals are now being amalgamated with, or converted into railways, being unable to withstand the competition with the railway.

Stationary-Engine System.—Of the numerous other systems or projects, in addition to locomotive engines and horses, which have been suggested for propelling carriages along railways, two only worth mentioning have been brought into operation, viz., traction by ropes wound round drums or cylinders, worked by stationary or fixed steam-engines, and the more recently introduced atmospheric system. Traction by ropes up steep planes had long been in use at the collieries in the North, where what are termed self-acting planes were established, upon which the descending loaded waggons attached to a rope, passing round a pulley-wheel, drew up by their superior gravity the empty waggons attached to the other end of the rope. The same principle was applied by Reynolds to transfer canal-boats from one level to another, in the case of the Ketley Planes, on the Shropshire Canals in 1788, also in the subterranean portion of the Bridgewater Canal at Worsley, in 1797, and at other places. The system of rope-traction by stationary engines was adopted in the collieries of the North, the steep undulating nature of the country being well adapted for it; Thompson applied the reciprocating system with great success to the Seaham and Durham Junction, and other railways, the lines being a series of successive planes, extending over 8 or 10 miles, without interruption, having fixed engines with ropes actuated by them, so that the traffic was transferred from one plane to another, taking advantage of gravity in the descents. The rope and stationary-engine system was applied to work the steep planes on locomotive railways, which were considered at the time too steep for the locomotives to travel upon, but recently locomotives have been so much improved, and rendered so much more powerful, that they can ascend planes at considerable velocities and with tolerable loads, where formerly it was considered impracticable. Examples of these may be mentioned;—the inclined planes of Edge-hill, and Rainhill on the Manchester and Liverpool Railway, the Lickey plane on the Gloucester and Birmingham, the Euston Square incline plane on the Birmingham Railway, and other places. The most remarkable and successful application of the rope system is, the Blackwall Railway, by Stephenson and Bidder, in 1840. The line commences at Fenchurch Street, and terminates at the East India Docks, Blackwall, being about 3½ miles long; it is carried upon brick arches above the streets, and at each end, or terminus, there are powerful fixed steam-engines, turning large drums or cylinders, round which the ropes for drawing the carriages are wound at the rate of 25 miles an hour. Each pair of engines at the London terminus, built by Maudslays, is 224 H. P., whilst each pair at the Blackwall end, built by Barnes, is only 140 H. P., the line descending all the way to Blackwall. The plan of accommodating the intermediate traffic is very simple and ingenious; it is effected by attaching the carriages to the rope, by a clutch worked by a lever; this is readily detached by a man on the carriage, whilst the rope is in motion, and answers perfectly. The planes between Fenchurch-street and the Minories are worked by the momentum of the carriages one way, and by gravity the other. This system has its advantages and disadvantages, and is more particularly applicable when the load is regular and constant, so that the full power of the engine may be employed to advantage. The wear and tear of the ropes is very expensive, but has latterly been much diminished, by the substitution of wire ropes for those of hemp.

Atmospheric Railways.—The atmospheric system has been the subject of much discussion here and elsewhere. It was first proposed in 1824, by Vallance, of Brighton, where a working model was constructed of sufficient dimensions for the carriages to be introduced at one end of a tunnel, and the air being exhausted by a steam-engine at the other, they were propelled forward, by the pressure of the atmosphere. It was even proposed to adopt the system for the speedy transmission of letters; the system, however, was necessarily so imperfect, that except for the ingenuity of the idea, it was of no practical utility. It was afterwards improved by Medhurst, in 1827, and was brought forward by Pinkus, in a more complete form, in 1834, by making the carriages travel outside the tube; and in 1839, it was further improved and patented by Clegg; since that period it has been brought into operation by Clegg and Samuda, who tried an experiment upon a working scale, in 1840, for about a mile in length, at Wormwood Scrubbs. This experiment showed that a load of 6 tons could be propelled at a velocity of 30 miles an hour, with an atmospheric tube only 9 inches diameter, and induced the leading proprietors of the Dublin and Kingstown Railway, to adopt it, for extending that line to Dalkey, a distance of about 1¾ mile, where the country was difficult, and not well adapted for locomotives. That extension was opened in the latter end of 1843, and has continued working ever since. The line is single; the rails, although rather lighter, are laid upon the ordinary plan, and in the centre between them there is a tube about 15 inches in diameter, having a slit or opening at the top, which is closed by an elastic valve; a piston, fitted to the foremost carriage of the train, is inserted into the tube, which is connected at the upper end with an air pump, worked by a steam-engine, which exhausts the air from the tube, and the piston attached to the foremost carriage is then urged along the tube by the pressure of the atmosphere, and draws the train with a velocity in proportion to the perfection of the vacuum in the tube: as fast as the piston advances, the valve in the slit of the tube is opened, and is closed again after the piston has passed, and is rendered tight and impervious to air by a composition of fatty matter placed in the groove into which the edge of the valve falls. The planes of this line are extremely steep, being in places 1 in 50, and the curves are very sharp. The highest vacuum obtained has been 26 inches, with a speed of 35 miles an hour. The train returns from Dalkey by gravity alone. For a first experiment, it has been tolerably successful. The system is being tried upon a larger scale upon the Croydon and the South Devon Railways; a portion of the former has been opened, and a speed of 60 miles an hour has been obtained, with a vacuum in the tube of 27 inches; and a train consisting of 10 carriages, weighing 50 tons, has been propelled 5 miles in 8½ minutes, or at the rate of 35 miles an hour, the barometer indicating a vacuum of 25 to 28 inches. The engines are 3 miles apart, and a power of 300 horses is employed for the whole distance. The tube is 15 inches in diameter, and the air-pump 6 feet 3 inches diameter; the steepest plane is 1 in 50. The South Devon line has not yet been tried.

Considering the recent introduction of this system, and the new contrivances required in all its details, much has been done; with further experience, it is not improbable but that much more will be effected. Pilbrow, in 1844, patented a modification of the system which is ingenious, but has not yet been sufficiently tested by experience to prove its merit. Hallette proposed to improve the valve on the top of the atmospheric pipe, by means of two small inflated elastic tubes, fixed in grooves on each side of the opening on the top of the pipe, through which the rod attached to the piston should slide between the tubes, and which should close the orifice as the piston moved. This ingenious idea requires the test of experience.

Steam Navigation.—The extraordinary improvement in the mode of communication, which has been effected by steam power and railways on land, had been preceded by equally surprising and important effects produced, by the application of steam to sea and river navigation. The vast increase of personal intercourse between people of different nations separated by the ocean, which has resulted from this great discovery, and which is still augmenting, has operated more than any other invention on record (not even excepting printing, which has been greatly extended by steam) towards realizing what was once considered Utopian, the bringing of the various nations of the world together, and uniting mankind into one great family, working harmoniously together for their common good. The steam engine, in its various and numerous applications, may justly be styled the grand improver and civilizer of the age. It is a gigantic yet docile labourer, equally well adapted for extracting fuel and other minerals from the bowels of the earth, as for performing all kinds of toilsome, complicated, or delicate operations, whether for forging the ponderous anchor and cable to preserve the gigantic vessel of war from shipwreck, or for weaving the most delicate web for a lady's garment. Its power can be increased to almost any extent, and it can be made to perform with a degree of celerity, economy, and skill, every operation which formerly could be executed by the human hand alone, and an almost infinite variety of others, which without it could never have been attempted. It may also be employed as a means of conveying merchandise, and travellers from one place to another, whether for business or pleasure, with a degree of certainty, expedition, convenience and economy attainable by no other agent. The increase of commerce, national industry, and wealth, as well as greater personal intercourse between nations, serves to dissipate prejudices, and to create reciprocal good feelings towards each other, and thus to promote peace; but if, unhappily, war should ensue, then by the increased facility afforded for attack and defence, steam would equally serve to shorten its duration by rendering the results more decisive, and making mankind less willing to embark in it.

The origin of the application of steam for propelling vessels is claimed by several individuals of different nations; but it is generally admitted that to Great Britain is due the merit of having introduced and established the successful practice of the present age. The application of wheels to propel boats dates as far back as the Romans; in 1682, Prince Rupert's barge was propelled in a similar manner, and tug vessels, with wheels worked by horses, for towing vessels against wind and tide, were proposed. Papin proposed, in 1690, to propel boats by racks and pinions with pistons working in steam cylinders; Blasco de Garay, a Spaniard, is said to have made an experiment on propelling a vessel in the presence of the Emperor Charles V., at Barcelona, in 1543. The experiment is reported to have succeeded, and received the approbation of the emperor, who paid all the expenses. The invention, if it existed, died with the inventor, and nothing further was heard of it, until after the introduction of steam navigation, when the statement was made in order to claim for Spain the merit of this great invention. Had this claim been brought forward earlier, and published to the world, it perhaps might have been allowed; but appearing at this time, it could have no influence, and must clearly be regarded as in no way interfering with the title of Great Britain to the discovery. Jonathan Hulls, in 1737, published a small pamphlet, wherein he gives a plate representing a boat with a wheel attached to the stern, driven by a steam-engine to propel the boat, and tugging behind her a vessel of war. This is clearly the first representation on record of a steam-boat. He took out a patent for the invention; but experienced so much opposition from prejudice, that he does not appear to have prosecuted it afterwards. Hulls proposed to apply Newcomen's engine for propelling the wheel, but as it was very difficult to produce rotatory motion with that kind of engine, that may have been one reason why it was abandoned. Savery proposed, in 1698, to apply manual power to the capstan of a ship, by the intervention of a wheel and pinion for turning paddle-wheels attached to the sides of the vessel; and, at a later period, Captain Burton proposed a similar plan. All idea, however, of bringing the invention to bear appears to have been laid aside until 1765, when the mechanical and scientific world had again turned their attention towards the improvement of the steam-engine, and Dr. Robison, of Edinburgh, proposed to Watt to apply steam for propelling vessels on land and by sea. Watt, however, at that time had not made sufficient progress with his invention, to enable him to take up and work out the idea with sufficient prospect of success, as it is evident, that he could not have considered Newcomen's engine at all calculated for the purpose; Watt, therefore, confined his views to perfecting his engine, foreseeing, no doubt, that when once that end was accomplished, other important results would follow.

The subject of steam-boats still lay dormant for a time. In 1782, the Marquis de Jouffroi is said to have made a steam-boat, 140 feet long and 15 feet wide, which was tried on the Soane at Lyons, but it was not successful. About the year 1787, Watt had so far perfected his steam-engine, and rendered it capable of producing rotatory motion, as to enable it to turn mills: he had thus overcome one of the principal difficulties, and prepared the way for the introduction of the modern system of steam navigation; but although numerous attempts were made with imperfect engines for propelling vessels, even after Watt had obtained patents for his improved engines, yet it was not until after the expiration of his patent for the rotatory engine, in 1800, that it was applied to steam-vessels.

About the year 1788, Fitch and Ramsey, of America, and Serrati, of Italy, appear to have tried some experiments, and thus they lay claim to the invention, but upon this point there is no accurate information. In the same year, Miller, of Dalswinton, constructed a double boat, 60 feet long, with two paddle-wheels in the centre, to be moved by manual labour, in order to race with another boat propelled by oars in the usual manner; it was tried upon the sea near Leith, when Miller beat his competitor, and the effect of this experiment convinced him, that power only was wanting to bring the invention to perfection. Taylor proposed to apply the steam-engine for this purpose, and he then applied to Symington, a practical engineer of the day (who had previously proposed some improvements in Newcomen's engine, and had made a model showing how it might be applied for the purpose of propelling carriages), in order to assist him in applying the steam-engine for working paddle-wheels. A steam-engine with two cylinders, 4 inches in diameter, each of about one-horse power, was accordingly made by Symington and Taylor, and was applied to drive the paddle-wheels in the centre of the double boat, employed for pleasure on Dalswinton Lake, in the middle of October 1788, when it attained a velocity of about 3 miles an hour. The success of this experiment was complete as far as it went, and established beyond doubt the merits of the discovery; it therefore induced the ingenious and persevering projectors to prosecute it further by making another vessel of the same dimensions as the former one, to be worked by an engine upon a larger scale: the engine was made at Carron, and was of a peculiar construction, in order to avoid infringement on Watt's patent; it had two atmospheric cylinders of 18 inches diameter, the pistons of which were connected with a lever acting alternately and by means of chains; pulley-wheels and ratchets turned two paddle-wheels, one being placed before the other, in the space between the two parts of the double boat; this machinery, it will be observed, was similar to Hull's plan, improved, however, by having two cylinders. The boats and engines were completed, and the experiment was tried on the Forth and Clyde canal on the 26th December, 1789, and was still more successful than the first, having attained a velocity of 4 or 5 miles an hour. An account of this experiment was published in the Edinburgh newspapers of the day. The signal success of this second steamboat, rendered further experiments unnecessary, and it now only remained to bring it into practical operation. Messrs. Miller, Symington, and Taylor had proved to the world, the merits of the discovery, and not wishing to incur further expense or trouble in combating the prejudices and opposition of mankind, which invariably obstruct the introduction and prosecution of every great invention, did not prosecute the subject further, but left it to others to work out and develope the powers of their extraordinary invention, which was destined, at no distant period, to produce such a wonderful revolution in the social world. The engines and machinery were accordingly taken out, and deposited at the Carron Works, and the boat, which was only a pleasure-boat, and fit for no other purpose, was transferred back to the lake of Dalswinton, and again applied to its original purpose. Mr. Miller returned to his agricultural pursuits; Taylor to his profession of a tutor; and Symington to his profession of a practical engineer.

In 1793, Ramsay made some experiments for propelling a vessel by forcing water out of the stern by a steam-engine; this does not appear to have answered.

In 1795, Earl Stanhope, well known for his mechanical genius, tried an experiment for propelling a vessel, by means of a propeller in the form of a duck's foot; and about the same time Smith fitted a boat with an atmospheric engine on the Sankey Canal; none of these experiments, amidst several others which were tried, appear to have been very successful; the great difficulty seems to have been, in producing the rotatory motion by the steam-engine employed for the purpose, and it is singular that none of them tried Watt's engine, which had then become generally known, and Boulton and Watt themselves were too busy in making their engines for the numerous mills and waterworks then becoming daily more general, to turn their attention to fresh speculations, the issue of which was at that time doubtful, and which did not promise to be so lucrative.

In 1801, Lord Dundas, who took great interest in mechanical pursuits, employed Symington to construct a steam-boat; this was propelled by an engine on Watt's plan, having one cylinder placed horizontally, and the piston, with a stroke of 4 feet in length, was jointed at the extremity, and attached to a connecting rod, with a crank at one end, turning a paddle-wheel, placed in a well-hole at the stern of the vessel, which had two rudders, one on each side of the cavity in which the paddle-wheel was placed. This was the first practical working steam-vessel, with an engine on Watt's system, and was called the 'Charlotte Dundas;' it was employed for towing vessels on the Forth and Clyde canal, and answered its purpose completely, but the proprietors of the canal objected to its being continued, in consequence of the agitation of the water produced by the paddle-wheels, which they alleged would injure the banks of the canal. In 1802, Fulton, who had been some time in England, hearing of Symington's attempts, went to Scotland, visited him on board his boat, and requested to see it tried. Symington accordingly got up the steam, made several trips up and down the canal, and fully explained to Fulton every part of the boat, steam-engine, and apparatus. Fulton made notes of everything, observing at the same time, that the objection of injuring the banks of the canals and small rivers might apply in England, but that in America, where they were upon a much larger scale, this inconvenience could not be felt, and he thought the application of steam-boats in that country, would be of immense public and private advantage, and stated his intention of introducing them there. After this visit to Symington, Fulton proceeded to France, where he constructed his first steam-boat, and tried it on the Seine, at Paris, in 1803, and proceeded to America soon afterwards. It is rather singular that Napoleon, who was then First Consul, and who usually was alive to all great improvements, and carried them through with a degree of energy and talent which overcame all opposition, should not have appreciated the merits of the steam-boat, and should have allowed such a fine opportunity of benefiting France to have slipped through his hands; but perhaps the same may be said of England, as being still more extraordinary, for the advantages of the steam-engine and machinery, had then become universally acknowledged. Fulton, however, impressed with the importance of the invention, and being thoroughly convinced of its ultimate success, pursued it with unremitting perseverance and energy, and in 1805 he applied to Messrs. Boulton and Watt to make a steam-engine for a boat which he was about to construct in America: this boat was accordingly built in 1807. Watt's steam-engine reached America in 1806. The vessel was named 'The Clermont,' from his friend Livingstone's residence; the wheels and machinery were on Symington's plan, propelled by Watt's engine; the boat was tried on the Hudson River, and only attained a speed of 5 miles per hour. This was the first steam-boat used in America, and Fulton and Livingstone then took out patents for introducing steam-boats in various places in America, and built several others, upon a larger scale, for carrying goods and passengers, employing Messrs. Boulton and Watt to make the steam-engines, which were sent from England, each succeeding engine being larger than its predecessor. Although it was generally known that the steam-boats had succeeded perfectly in America, and that their employment was daily increasing, yet little or no attention was paid to the subject in England. The idea of employing steam-boats on the ocean, had never been conceived, and the objections raised to the agitation of the water by the paddle-wheels on the Forth and Clyde canal, were considered so strong, that doubts were generally entertained as to the success of the system anywhere but in large rivers, such as those of America. In 1812, however, Henry Bell, of Glasgow, who was well acquainted with, and had deeply considered all that had been done by Symington, determined to try once more whether the invention could not be applied on the Clyde; he accordingly caused a small boat of 25 tons burthen to be built at Port Glasgow, by John Wood, who has since become so well known as a ship-builder; it was 40 feet long, with 10 feet beam, and in it was placed a steam-engine of 4 H.P., on what was termed the bell-crank principle, introduced by Watt; the boiler was placed on one side of the vessel and the engine on the other, with four paddle-wheels worked by the intervention of spur gear; the wheels consisted of detached arms, with paddles or floats at the end, which, however, did not answer, and the complete wheel, according to Symington's plan, was subsequently adopted. This boat, which was called the 'Comet,' began to ply for goods and passengers on the Clyde, between Glasgow and Helensburgh (Bell's native place), in January, 1812, and attained the speed of 5 miles an hour.* The 'Comet'

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* In the collection of the Institution of Civil Engineers is the following handbill:—

"STEAM PASSAGE BOAT, THE 'COMET,'"

BETWEEN GLASGOW, GREENOCK, AND HELENSBURGH, FOR PASSENGERS ONLY.

The subscriber, having at much expense fitted up a handsome vessel to ply succeeded so well, that Bell determined to build another vessel of larger dimensions and power. Numerous other parties, seeing the success which had attended Bell's exertions, determined to follow his example, and several other boats were built during the succeeding years of 1813 and 1814; they were however, still very imperfect, until Cook, of Glasgow, in 1814, constructed the fourth vessel, the 'Glasgow,' with an engine of 16 H.P. The machinery of this vessel was so much more perfect and powerful than any which had been previously constructed, that it served as a model for many others; and from this period steam-boats for river navigation were completely established.

Many of the engines employed for the above-mentioned vessels were upon the bell-crank principle; which, from their simplicity and portability, standing upon an independent frame, with the condenser forming part of it, were well adapted for steam-boats, and were consequently generally used. The bell-crank levers, receiving the motion direct from the piston, communicated it by means of a connecting rod and crank to the main shaft, turning the paddle-wheels on each side of the vessel; the engine was placed on one

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upon the River Clyde between Glasgow and Greenock—to sail by the power of wind, air, and steam, he intends that the vessel shall leave the Broomielaw on Tuesdays, Thursdays, and Saturdays, about mid-day, or at such hour thereafter as may answer from the state of the tide; and to leave Greenock on Mondays, Wednesdays, and Fridays, in the morning, to suit the tide.

The elegance, comfort, safety, and speed of this vessel require only to be proved to meet the approbation of the public; and the proprietor is determined to do everything in his power to merit public encouragement.

The terms are, for the present, fixed at 4*s*. for the best cabin, and 3*s*. the second; but beyond these rates, nothing is to be allowed to servants, or any other person employed about the vessel.

The subscriber continues his establishment at Helensburgh Baths the same as for years past, and a vessel will be in readiness to convey passengers in the 'Comet' from Greenock to Helensburgh.

Passengers by the 'Comet' will receive information of the hours of sailing, by applying at Mr. Housten's office, Broomielaw; or Mr. Thomas Blackney's, East Quay Head, Greenock.

Helensburgh Baths, August 5, 1812.* HENRY BELL.

Mr. Bell presented this new method of navigation to the British Government at three different times, viz., in 1800, 1803, and 1813,* when, after all his exertions, it was thought to be of no utilty to Government. After it was denied him in 1803, he thought it very hard that such a discovery should lie dormant; and, on that account, he sent a description of the method of applying steam in propelling vessels against wind and tide, to all the emperors and crowned heads in Europe, and also to America, which last government put it in practice in the year 1806.

* Thus in the original.

side of the vessel and the boiler on the other. The boilers generally used, were upon the principle proposed by Allen in 1730, and Smeaton in 1765, having an internal furnace and flue, surrounded by the water. This form of boiler was first brought into use by Trevithick in 1803, for high-pressure engines, and for low-pressure engines, also, in one of the earliest steam-dredging boats, employed at Portsmouth Dockyard, under Bentham; but the exterior shell of this boiler was of wood, as proposed by Brindley in 1758; in steam-vessels the external shell of the boiler was made of wrought iron. All the steam-vessels above mentioned were worked by one engine only. In 1814, Boulton and Watt first applied two engines, connected together, for working a small boat on the Clyde.

In 1815, a small vessel, with a side-lever engine of 14 H.P. by Cook of Glasgow, made a voyage from Glasgow to Dublin, and round the Land's End to London; it then ran between London and Margate with passengers with considerable success, and this led to others being established in various places; the Scotch boat serving as a model.

In 1816, Maudslay made a pair of combined engines, each 14 H.P., applying the power to the paddle-wheel shaft by the crank, instead of by cog-wheels, according to the previous mode.

In the same year, the late Mr. Baird constructed a steam-boat at St. Petersburgh, with a boiler set in brickwork; this boat worked for some time on the Neva; a drawing of it exists in the archives of our Institution.

In 1817, Boulton and Watt purchased a small steam-boat called the 'Caledonia,' which had been built in the Clyde, with very defective engines. James Watt, jun., having constructed a new pair of combined engines on the side-lever principle, of 14 H.P. each, made a great number of experiments with the 'Caledonia,' and went with it to the Scheldt and other places; the arrangement of the engines, as improved by Watt, served as a model for several other vessels.

In 1818, David Napier caused the 'Rob Roy,' of 90 tons burthen, to be built by Denny at Dumbarton, with an engine of 30 H.P., with which he successfully established a regular communication between Greenock and Belfast: this may be said to be the first time that a regular communication by steam-boats, between two distant sea-ports, was established, and it set the example to every other place. Boulton and Watt, after the success of the 'Caledonia,' made a great number of marine engines of increased power, and with various new improvements, such as introducing wrought iron instead of cast-iron for several of the moving parts; and in 1821, a great step was made, by establishing steam-boats between London and Leith. Two of these vessels, the 'James Watt' and the 'Soho,' with engines of 120 H.P., by Boulton and Watt, were the largest which had been made, and answered very well.

In 1819, the 'Rob Roy' left the Belfast station, and was transferred to the English Channel, to run between Dover and Calais. About this time Napier built the 'Talbot' of 150 tons, with two engines of 30 H.P. each, which ran regularly between Dublin and Holyhead. In this year also, the late Mr. Rennie, who had for some time previous watched the progress of this great invention with considerable interest, foreseeing that it would ultimately supersede all others, proposed to the Admiralty to use steam-vessels for towing vessels of war into and out of harbour against wind and tide; being perfectly satisfied, that if once it was introduced into the navy, it could not be long before steam-vessels of war would follow; great doubts, however, as to its success were entertained and expressed by many of the official subordinates. Lord Melville and Sir George Cockburn, however, overruled all objections, and, as a first experiment, they consented to allow the 'Hastings,' a 74 line-of-battle ship, to be towed from Woolwich by the 'Eclipse,' a Margate steamboat of 60 H.P. The 'Eclipse,' however, proved too weak, and after towing the 'Hastings' a few miles, it returned, and the 'Hastings' went to Chatham with her sails alone; the experiment was thus not quite so successful as could have been desired; nevertheless Rennie still determined to persevere. Oliver Lang, the master-shipwright of Woolwich Dockyard, entered fully into Rennie's views, and warmly assisted by every means in his power the introduction of steam-vessels into the navy, contrary to the opinions of many of his superiors. At length the Admiralty, at their recommendation, ordered the 'Comet' to be built according to the draft and plan, and under the superintendence, of Mr. Lang; she was 115 feet long and 21 feet wide, drawing 9 feet of water, and a pair of engines, of 40 H.P. each, were ordered for her from Messrs. Boulton and Watt: this was the first steam-vessel in the navy, and it is still in use. By degrees several others were built.

In 1820 a steam tug was built by Manby, for Messrs. Smith, for the purpose of towing their barges upon the Humber; and in the same year, Maudslay and Field applied the expansive action of steam in the cylinder, which was a great improvement; also escape valves for the water, which might boil over into the cylinders. In that year also, steam-packets were introduced on the post-office station between Holyhead and Howth; and the 'Britannia,' with oscillating engines, and several other steam-packets, were built by Manby for the Dover and Calais station.

In 1825, the General Steam Navigation Company was established by William Jolliffe, who built two of the largest vessels which had yet been tried, called the 'George the Fourth' and the 'Duke of York;' they were between 500 and 600 tons burthen, and had engines of 130 H.P., furnished by Messrs. Jessop of the Butterley Iron Works: these two vessels were intended to establish a regular communication between London and Cadiz and London and St. Petersburg; they accordingly started in September, 1827, and answered extremely well, notwithstanding the heavy storms which they encountered in the Bay of Biscay and in the Baltic. The General Steam Navigation Company, considering the ideas of Jolliffe too extended, parted with the two vessels (which were afterwards purchased by the Government), and limited their views to the British Channel and the German Ocean. About this period, the 'Enterprise,' of 500 tons burthen, which was built by Gordon, and had a pair of combined engines of 120 H.P. constructed by Maudslay and Field, made the voyage from London to Calcutta, by the Cape of Good Hope. The advantage and superiority of steam-vessels, in every respect, for both river and sea navigation, having been now thoroughly established, their employment became universal; and the size, power, and number of the vessels increased daily in every part of the empire.

From this period nothing remarkable appears to have occurred, until the construction of the 'United Kingdom,' which was by far the largest in size and the most powerful that had been made. She was 160 feet long, 26½ feet beam, and 200 H.P.; the vessel was built by Steele, of Greenock, and the engines by David Napier. As deep-sea navigation by steam advanced, it became an object of considerable importance to save fuel, and to obviate the inconvenience of the incrustation of the boilers by the deposit of salt, and other sediments occasioned by the use of sea water; David Napier therefore introduced the system of surface condensation, the condenser being made of a series of small copper tubes, through which the steam, after being used, passed from the cylinder to the air-pumps, the pipes being surrounded by a constant supply of cold water, so that the steam was condensed and the water was returned directly back into the boiler, to be again converted into steam, without the admixture of salt water according to the usual plan, thus employing the same fresh water over again, whereby the above-mentioned inconvenience of incrustation of the boilers was in a great measure avoided. Hall afterwards tried the same system with certain modifications, and it was employed in several vessels; but like Watt, Cartwright, and others who had tried it, he found the condensation was not so complete, and the weight, and cost, and the difficulty of keeping the apparatus in order, has hitherto prevented it from being generally used; for although it possesses advantages in many respects, still upon the whole they do not counterbalance the disadvantages, and the old system of condensation by jet, with the aid of the brine pumps, is more generally employed. The brine pumps and refrigerators were invented and patented by Maudslay and Field in 1825, and were used on board the 'Enterprise.' After the 'United Kingdom,' numerous vessels of similar and even greater size were constructed, to ply between London and Leith, Glasgow and Liverpool, and elsewhere.

The next great step in advance was the crossing the Atlantic. This had long been in agitation, and was freely discussed by numerous enterprising minds, anxiously bent upon working out the fulfilment of such a desirable and important object; but the great practical difficulties involved in the execution were not so easily overcome.

To construct a vessel of sufficient size, with engines of adequate power to propel her through the storms of the Atlantic, and carrying with her sufficient fuel to keep the engines in motion, was considered by many (and among them were very competent authorities) to be extremely doubtful, but by the world in general the task was considered to be wholly impracticable. To Bristol is due the origin of this great undertaking, and a Company of enterprising individuals, with Brunel, as their consulting engineer, was formed for that object; it was, however, with difficulty that they found engineers to carry it into effect, some of the first constructors of the day having declined to undertake it. Messrs. Maudslay and Field, however, who had already taken such a prominent part in the prosecution of steam navigation, saw their way, and boldly engaged to construct engines of the requisite power, well adapted for the purpose. Accordingly a vessel, called the 'Great Western,' was designed by Paterson, and built by him at Bristol; and the engines were completed and fitted on board in March, 1838. The vessel was 210 feet long, and 38 feet beam, drawing 15 feet when laden, being 1240 tons burthen, and capable of carrying 500 tons of coals, which it was calculated would last twelve days. The engines were upon the side-lever principle, each of 210 H. P., with cylinders 73 inches diameter and 7 feet stroke, making 15 strokes per minute; they were fitted in cast-iron frames, with the latest improvements. The boilers were constructed with the flues over the fires; they were called double-story boilers, and have been since much used; they had brine pumps, and were worked under a pressure of 5 lbs. per square inch; the total weight of the engines and boilers, including the water and the paddle-wheels, was about 420 tons. The vessel was completed with her engines, and made her first trial on the

Thames in March, 1838, realizing 12 miles per hour. On Sunday, 8th April, she started on her first voyage from Bristol, under the command of Captain Hosken, with seven passengers, and a cargo of 50 tons of goods, besides 500 tons of coals, and reached New York on Monday, 23rd April, a distance of 3000 miles, in thirteen days and ten hours. Her arrival created the greatest interest; the quays were crowded with spectators, anxiously waiting to give a hearty welcome to the enterprising and successful adventurers, who had thus so triumphantly solved the grand problem, and had brought the New World within a few days' sail of the Old. On her return she left New York on the 7th May and reached Bristol on the 23rd, with 70 passengers; performing the voyage in fifteen days. The success of this voyage across the Atlantic having exceeded the most sanguine expectations of its promoters, and indeed of the whole world, there seemed no bounds to the extension of steam navigation; other companies were projected and numerous larger and more powerful vessels were designed, in equal confidence of success; then followed the 'British Queen,' by Napier, of 500 H. P., the 'Liverpool,' of 500 H. P., and the 'President,' of 600 H. P., whose melancholy fate served for a time to damp the ardour of speculation. The practicability of steam communication across the Atlantic having thus been established, and its superiority over the old sailing system being clearly proved, time only was necessary to render it perfect. The line from Liverpool to Boston was then designed, and carried into effect by Cunard, for conveying the mails; it consisted of four fast vessels, the 'Acadia,' 'Caledonia,' 'Hibernia,' and 'Cambria,' of about 1000 tons and 450 H. P. each. This was followed by the gigantic project of the Royal Mail Company, for carrying the mails between England and the West Indies, consisting of twelve vessels, each of about 1200 to 1300 tons burthen, and 420 H.P. The engines of these vessels resembled very much those of the 'Great Western,' whose complete success induced their being taken as models for others. The great weight and space occupied by these engines, being upon the average about a ton for every horse-power, rendered it difficult for them to carry any great amount of cargo beyond the passengers, and thus the profits as a mercantile speculation were materially lessened; it became extremely desirable, therefore, to ascertain whether engines, equally efficient, could not be made of less weight, and to occupy considerably less space.

In order to effect this object, engines were invented, by which the power was applied directly from the piston to turn the paddle-wheel shaft, without the intervention of side levers; these were called direct-acting engines, and at first great objections were made to them in consequence, as was asserted, of the loss of power arising from the obliquity of the action of the piston-rod upon the crank on the paddle-wheel shaft. Messrs. Seawards were among the first to introduce this system into the 'Gorgon,' and notwithstanding the objections above stated, it has been improved by them and by other engineers, and has materially gained ground. The obliquity of action of this system, compared with that of the side-lever system, can only be considered in the light of a little extra friction, which is fully, if not more than compensated for, by the reduction of weight and space. The modifications of the system by Miller, have been very successful, and combined with the forms of vessels adopted by him, have enabled great speed to be attained both by sea-going vessels, and his boats on the Rhine and other rivers. Even the objectionof extra friction, however, if tenable, is obviated by the vibrating cylinders described in Trevithick and Vivian's patent in 1802; patented by Witty in 1813, and by Manby in 1821, by whom the first engines of the kind were constructed; subsequently improved by Maudslay and Field, and Spiller; and now extensively manufactured by Penn, Miller, and others; Maudslay and Field's double cylinder engines, so arranged that a long connecting rod is obtained by its being enabled to descend between the cylinders; the Trunk engine by Humphery; and the modification of the concentric cylinders by Joseph Maudslay; as well as other varieties of this system by different makers. The substitution of wrought iron for cast in a large portion of the frame and condensers; the tubular instead of the common flue boiler, first proposed by Blakley in 1764, and afterwards improved in the locomotive boiler, and introduced into steam vessels by Maudslay, Spiller, Bramah, and others about the year 1829, as well as the use of steam of higher temperature and increased expansive action, have combined materially to increase the effect of the engines, and reduce the consumption of fuel; so that the space and weight occupied by them is now reduced to nearly one-half what it was originally, or in other words, engines of double the power now only occupy the same space and tonnage in the vessel; thus a material advantage has been gained in enabling vessels to carry a larger quantity of fuel, by which they can extend their voyage; and greater power is rendered disposable for propelling the vessel through the water. As economy of time becomes daily more important, every means which can effect it are brought into operation, and thus the power of the engines has been continually augmented, in order to produce greater speed and shorten the duration of the voyages. Referring to the navy, we find, that in 1822, 80 H. P. was the largest; in 1827, 160 H. P.; in 1828, 200 H. P.; in 1830, 220 H. P.; in 1838, 440 H. P.; and in 1845 we have the

'Retribution' and 'Terrible,' with nearly 1000 H. P. in each, and it is not improbable that, ere long, greater power will be employed.* Whilst the royal steam navy has been making such rapid progress, the mercantile steam navy has not only kept pace with it but has even led the way; for the enterprising, commercial spirit of this country is ever on the alert; every improvement is seized upon with avidity, and the greatest inducements are held out to make new discoveries; in fact nothing but constant progress can satisfy the restless spirit of improvement. In the infancy of the art, we were satisfied with 5 or 6 miles per hour, now, when we have attained above 17 miles per hour, we are confidently looking to a still greater result.

Whilst the improvements, above described, have been making in the engines and in the mode of applying them, various attempts have been made to obviate the inconvenience and loss of power occasioned by the concussion of the floats of the ordinary paddle-wheel entering the water, as well as the heavy drag or back action of the water when the floats leave it; numerous experiments and inventions have been tried for constructing a wheel, of such a form that the floats shall always enter the water in the most advantageous manner, and having effected the object, shall leave it again with the least resistance. To describe the numerous inventions of this kind would be foreign to my purpose, and would occupy too much of your time; it will suffice to mention that of Buchanan, by which the floats always enter and depart from the water perpendicularly; those of Cavé, Oldham, Morgan, Perkins, Seaward, and Barnes, which are modifications of it, differing chiefly in the angle at which the floats enter and leave the water, and the mechanism attached to the wheel by which the motion is communicated to the float-boards; the principle of this invention is extremely good, but in practice it has unfortunately been found, that the wheels of this construction, after a little use, are liable to get out of order; it is not therefore generally adopted, although, whilst they are in order, considerable advantage is doubtless gained. To obviate this inconvenience, as well as that of the common wheel, Field invented what is technically termed the Cycloidal Wheel; this consists in dividing each float board into several parts or narrower boards, and arranging them so nearly in cycloidal curves that they shall all enter the water at the same place in immediate succession; as the acting force of each board is radiating, it propels whilst passing under the water in the ordinary way, and when it emerges, the water escapes simultaneously from each narrow board; this principle was not followed up by its inventor, and was afterwards patented by Galloway, since which it has been very generally adopted. The principle of reefing the paddle-wheels is also used, so that when the vessel is deeply immersed, the leverage of the paddles can be shortened, and when light, it can be lengthened, and can thus be always adjusted to the power of the engines.

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* The total amount of steam power employed in the Royal Navy is about 35,000 H.P.

As economy of fuel is an object of the greatest importance, so in long voyages it is advisable to employ the wind as a moving power, as much as possible, when favourable: it became therefore desirable to contrive a simple means of detaching the paddle-wheels from the engines, so as to allow them to turn round with the motion of the vessel through the water, and thus to prevent them from impeding her way; various contrivances of this kind have been invented, but one of the most simple, and which is now much employed, was invented by Braithwaite and Milner; it consists of a friction clutch attached to the paddle-shaft, which, by means of keys and screws, can be tightened or slackened with facility, and thus the paddle-wheel is attached or released at pleasure. Numerous attempts have been made to introduce the rotative engine without pistons, but they have hitherto not been successful.

The great results rendered by steam navigation induced the mechanical world to turn their attention towards the extension and improvement of it; Boulton and Watt, Maudslay, Field, Robert and David Napier, Jessop, Glynn, Barnes, Miller, Ravenhill, Girdwood, Manby, Spiller, Scott, Sinclair, Caird, Todd, Fawcett, Bury, Forester, Seaward, Penn, Fairbairn, Hall, Rennie, and numerous other able men devoted their minds to it, and have produced some splendid examples of engines and mechanism in that department. When we look back to Symington's original engine, in 1788, it appears to have been so changed as scarcely to be recognisable as the same, and from a speed of 5 to 6 miles an hour in smooth water, we now find that a speed of 8 and 9 miles an hour against a heavy gale and head wind in the Atlantic, and above 17 miles in still water, has been obtained, whilst improvements are in progress which lead us to anticipate at no very distant period far greater results; much of this, no doubt, is due to the perfection of the workmanship, as well as to the more correct proportions and adaptation of the various parts of the machinery, compared with what was formerly done, and which it was impossible to accomplish with the slender and inefficient means then at command; for this we are greatly indebted to the improved self-acting tools of Whitworth, Fox, Lewis, Sharpe, Roberts, Nasmyth, and others. The improvements in the form and construction of the vessels have also contributed much; and in the investigation of this difficult subject we are much indebted to John Wood, Oliver Lang, Fearnall, Fincham, Ditchburn, Symonds, Rule, Seppings, Scott Russell, Edye, Patterson, White, Pasco, and others.

Iron Vessels.—Neither must we forget the very important improvement in the introduction of iron for the construction of vessels, which enables us to combine lightness and elegance of form with strength and durability. For this valuable addition to marine architecture we are indebted to Aaron Manby. In 1820–21 he constructed at Horseley, near Birmingham, a wrought-iron boat, called the 'Aaron Manby,' 120 feet long and 18 feet beam, and when laden drawing 3 feet 6 inches water; it was propelled by Oldham's feathering paddle-wheels, worked by a single engine of 80 H. P.; and was built for the purpose of plying on the river Seine. The boat was completed in 1821–22, and was navigated across the Channel by the present Sir Charles Napier, who was deeply interested in the undertaking; it was not only the first iron vessel that ever made a sea voyage, but also the first that conveyed a cargo from London to Paris direct, without transhipment. She continued plying between Paris and Havre for several years, until superseded by other more powerful and improved boats: the hull is yet in existence, and is still used with new engines on board, as are three others, which were built about the same time. In 1832 Maudslay and Field built four iron vessels for the East India Company, for the navigation of the Ganges, and fitted them with oscillating engines, of the united power of 60 horses; they were 120 feet long, 24 feet beam, and drew 2 feet water; they were so successful that six more were ordered shortly afterwards. The use of iron, however, did not make much progress until recently, on account of the prejudices and obstacles which generally, if not invariably, impede the progress of all great inventions. At present, iron is much employed for vessels, and promises in many cases to supersede timber. Objections against its general employment have been urged, on account of the bottoms of the vessels being liable to become foul on long voyages, and for the purposes of war, the splinters of the iron when struck by shot are said from recent experiments to be more detrimental than from wood. The art of building iron vessels is, however, in its infancy, and it is very probable that further experience and investigation will, in a great measure, obviate the evils. The strength, lightness, and other qualities that have been mentioned, give it great advantages for the construction of fast-sailing passage-vessels, and the water-tight bulkheads constructed with it, give great additional security in case of accidents; these water-tight bulkheads are now almost universally adopted; but the precise date and origin of their introduction is not very clear. Captain Evans, of Holyhead, proposed them for timber vessels in the year 1826, and soon after that time they were used in an iron vessel constructed by Grantham for C. W. Williams. Examples of their importance have frequently occurred, demonstrating the necessity of their introduction into all vessels, whether for river or sea navigation.

Screw Propelling.—Great as has been the result of steam-navigation under the paddle-wheel system, still as perfection is approaching, it cannot be denied, that it has several disadvantages when applied to sea navigation during stormy weather, which it is most desirable to obviate. Paddle-wheels act to the greatest advantage in smooth water and upon an even keel. The unequal immersion of the paddle-wheels during the rolling of the vessel, in a heavy sea, prevents that uniformity in the action of the engines, which is necessary to insure their greatest effect, and although this may be lessened, to a certain degree, by the use of mechanical or feathering wheels, as I have already stated, the complexity of their construction is objectionable. The resistance, offered by the paddle-boxes to the wind, in addition to their top weight, has a sensible influence in diminishing the speed and effect of the engines, and in ships of war, the great space occupied by the wheels on the broadsides of the vessels, materially interferes with the efficiency of the batteries; moreover, the wheel, as the principal propelling agent, being constantly exposed to shot, is under very considerable risk of having its efficiency impaired. The idea, therefore, of substituting for it some other propelling agent, had long been a favourite object of investigation amongst engineers. The origin of this, like every other great invention, is very difficult to be ascertained with accuracy, as the same idea not unfrequently occurs at the same time to different individuals, totally unconnected with each other. The first idea of stern-propelling was very probably suggested by the movement of fishes, whose chief propelling power exists in the tail, as also from the common and ancient practice of sculling a boat from the stern. A rude idea of stern-propelling is attributed to Duguet in 1727, but it was so totally different from the system now employed, that it can scarcely be called the same invention. His system consisted of two boats, connected together by two cross beams with a screw, inserted between the boats; this double boat was moored to a post in the river, and the current, acting upon the screw, turned it round, this motion thus generated, was communicated over pulleys, to which were attached the vessels to be drawn along; this plan may be likened to the effect of a water-wheel, or any other fixed first mover; still there is an idea of the screw, which, if pursued, might have been converted into screw-propelling. In 1768 Painton proposed the pteraphore to be applied to the bow and stern and sides of a vessel horizontally, but does not describe how it was to be moved. Lyttelton also proposed a screw-propeller in 1794. The first practical experiment, however, appears to have been made by Shorter in 1802, with a propeller like the sails of a windmill, applied to the stern of a vessel in the Thames. He afterwards tried several propellers, particularly in the 'Superb' line-of-battle ship in Gibraltar Bay, worked by a screw by the intervention of the capstans, by which the vessel was moved through the water at the rate of about 2 miles an hour.

Shorter does not describe the kind of propeller used in this experiment, although Napier, who afterwards proposed a similar plan without knowing what had been done, when he accidentally found Shorter, had from him an account of his experiments, and saw a large collection of propellers applicable to the bow, stern, sides, and every part of the vessel: Napier acknowledged and admitted that Shorter had conceived almost every possible kind of arrangement, and that his models and plans comprised most of the systems since made public by different parties; Shorter also exhibited several experiments with different propellers, and attributed the best results to a propeller with a single blade projecting from the axis. In 1824 a work was published under the direction of the French government, describing the several modes of propelling in use in America, on the principle of the screw; one plan was to have a hollow in the bottom of the vessel nearly as long as the vessel itself, with a screw revolving in it to produce motion forwards or backwards; another form of this system was to have a double screw between two boats. In 1825 a Company was formed for applying Brown's gas-vacuum engine to navigating boats on canals, and a premium was offered for the best invention for propelling boats without paddle-wheels. In 1827 the ingenious and indefatigable Tredgold, in his work on the steam-engine, described and investigated the theory of screw-propelling; about the same time, or perhaps rather before, Brown, the inventor of the gas-vacuum engine, proposed to apply a propeller, consisting of two blades placed at an angle of about 90° to each other and 45° to the axis; this was intended to be placed in the front of the bow of the vessel, and attached to a shaft working through a stuffing-box, which could be raised or lowered at pleasure. He obtained the premium of the Canal Towing Company for this, and they determined to pursue the subject further; in furtherance of this object, they built a vessel at Rochester with a gas-vacuum engine of 12-horse power, which was applied to working

Brown's propeller by means of bevil gear; the result of this experiment does not exactly appear, although it was considered sufficiently satisfactory for Brown to continue his investigations: he accordingly built another boat with similar engine and machinery, and made several experiments with it on the Thames, near London, when he is said to have attained the velocity of 7 miles an hour with it. Subsequently, Cameron, Woodcroft, Lowe, Ericson, and others pursued the subject and took out patents for various modifications of screw-propelling; nothing, however, was materially effected until the year 1836, when T. P. Smith obtained a patent for the application of a screw to propel vessels, by placing it in that part of the stern of the vessel called the "dead wood." He accordingly built a small vessel, and made numerous experiments with her on the Thames; this little vessel was 34 feet long, 6 feet 6 inches beam, and drew 4 feet water; in it he placed a small high-pressure engine, with a cylinder 6 inches in diameter, and 15 inches stroke, which was applied to working a screw 2 feet diameter, having a pitch of 2 feet 5 inches. With this vessel he obtained a speed of from 7 to 8 miles an hour; he then tried her on the sea between Ramsgate and London, and she answered very well in driving against the wind in a heavy sea. Upon the success of this experiment a Company, called the Ship-Propelling Company, was formed, Smith being their adviser, and under his directions a vessel, called the 'Archimedes,' of 232 tons burthen, was built in London by Whimshurst; she was 125 feet long and 21 feet 10 inches beam, having a draught of water of between 9 and 10 feet; she was propelled by a pair of engines of the united force of 80 H.P. The engines and machinery, which were made by Messrs. Rennie, instead of being placed transversely in the vessel as was usual in paddle-wheel steam-boats, were placed longitudinally; these engines were upon the direct-acting principle, and their power was applied to work the shaft upon which the propeller was placed, by means of two spur-wheels with teeth of hornbeam wood, and two pinions with iron teeth working into each other, the motion of the propeller shaft being 5·33 to 1; or, in other words, when the engine made 25 strokes, the propeller made 133·3 revolutions. The propeller, which was in the dead wood, was united to the shaft, by means of a water-tight stuffing-box passing through the stern of the vessel. The propeller at first consisted of a single-threaded screw; but this not answering so well, another screw was employed, with two threads opposite to each other, 5 feet 9 inches diameter, and 8 feet pitch. The 'Archimedes' obtained a velocity of 9 miles per hour through the water, and proved herself an admirable sea-boat, going head to wind in a heavy sea, and she established beyond all doubt the success of the invention, and its superiority over paddle-wheels in many cases; still, however, much remained to be done before prejudice could be overcome, and before the system could be brought to such perfection as to compete in velocity successfully with paddle-wheels, which had so long and so completely engrossed the public attention as scarcely to leave an opening for any other system; latterly, however, screw propelling has made considerable progress. In 1842, the 'Bee' was constructed by Maudslay and Field for the Government; she was worked by a steam-engine of 10 H.P., adapted for driving either the screw or the paddle-wheel in the same vessel, and thus to try the comparative merits of the two systems. From the trials and experiments made with the 'Bee,' it appeared, that upon the whole the paddle-wheels had an advantage as to speed under all circumstances. In 1840, the 'Dwarf,' of 210 tons burthen, which was the first screw vessel ever commissioned in the British navy, was constructed by Messrs. Rennie; the engines, of 120 H.P., upon the direct action principle, were attached to two spur-wheels, with two pinions for working the screw upon the propeller shaft, on the same plan as the 'Archimedes.' The 'Dwarf' proved herself an excellent sea-boat, and attained a speed of 12½ miles per hour through still water. The 'Rattler' was the second screw-propelling vessel introduced into the navy. She was 176 feet long, and 32 feet 8 inches beam; drawing 11 feet 3 inches water, carrying 20 guns, and was about 888 tons burthen. The engines, of 200 H.P., were by Messrs. Maudslay and Field; and her screw, which was 10 feet diameter, and 11 feet pitch, was driven by cog-wheels; the screw made 103 revolutions per minute, being in the proportion of 4 to 1 of the speed of the engines; her velocity through still water was 9½ miles per hour, and she proved a good sea-boat. All these have been surpassed in speed by the Royal yacht, the 'Fairy,' built for Her Majesty, by Ditchburn, with engines by Penn; she is 260 tons burthen, with two oscillating engines of the united force of 125 H.P., driving one spur-wheel and one pinion; the screw consists of two blades, and makes 250 turns per minute, being in the proportion of 5 to 1 of the moving power. The speed of the 'Fairy' is 15¾ miles per hour through the water. The merits of the screw system have now been so completely tested, that the Government have determined to introduce it more generally into the navy, particularly for guard-ships; these vessels are to be of two classes, line-of-battle ships and frigates; the former having combined engines of 550 H.P. the latter 350 H.P.; the cylinders of the engines will, in some cases, be applied horizontally, and the pistons will act directly upon the propeller shafts, by cranks, without the intervention of wheels; the propeller shaft will make from 50 to 60 revolutions per minute, and the speed of the vessels will be from 5 to 7 miles an hour; this velocity will be sufficient to enable them to command their own position; and with heavy guns and the free uninterrupted use of their batteries, they will be fully equal to cope with any vessels of their class. The 'Amphion' frigate is also being fitted with a screw propeller, to move with a greater velocity than the guard-ships. She is 1290 tons, was originally built for sailing, and carries 36 guns; she is propelled by a screw of two blades, 15 feet diameter, and 21 feet pitch, driven by a pair of engines of 300 H.P., making from 45 to 50 revolutions per minute; her speed on trial was 7 knots an hour, and promised more; the whole was designed and executed by Messrs. Miller and Ravenhill. To Miller the constructive portion of marine engineering owes much; the forms of framing, the graceful proportions, and scientific combination of strength with lightness; the arrangement of the several working parts of the engines, so as to diminish the weight, and increase their compactness, without impairing their efficiency, have produced the natural consequences, not only in the fast river boats on the Thames and the Rhine, and other rivers where peculiarities of construction were specially demanded, but also in the sea-going vessels, for the mercantile as well as for the Royal Navy and the post-office service of both France and England.

Much discussion has already taken place, and is still going on, as to the best form and dimensions of propellers; nothing, however, but careful and well-conducted experiments can determine this important point. In these investigations Rennie has taken a leading part; Smith, Lloyd, Sunderland, Barlow, Guppy, Brunel, Airy, Maudslay, Field, Miller, Barnes, Penn, and others have also done a great deal. Up to the present time the double-bladed propeller has produced as good a result as any other form. In the first application of steam power to screw, or stern propelling, cog-wheels were usually employed to drive the propeller; then straps, or bands, working upon wooden or iron cylinders; and in the 'Great Britain,' endless chains were employed; in this case, however, the chain had claws, resembling teeth, attached to it, which fitted into corresponding recesses or cavities, on the drum, and to a certain degree, prevented the stretching or slipping to which chains of the ordinary description are liable; adhesion wheels were also tried by Messrs. Rennie, but were not found so good as cog-wheels. Latterly the system has been much simplified, by applying the piston of the engine to act directly upon the propeller shaft, and a successful result appears probable. Whilst upon this subject, the 'Great Britain,' the largest vessel constructed in modern times, must not be omitted. She is 322 feet long, 50 feet 6 inches beam, draws

16 feet of water, and is 3444 tons burthen. She is propelled by the screw, with a pair of engines of the united force of 1000 H.P.; there are four cylinders, inclining at an angle of 60°, and parallel with the keel; the pistons act by means of cranks upon a large wheel, which turns the drum with the chain and propeller shaft; the diameter of the screw is 15 feet 9 inches. She left Bristol on her first trial on the 8th January 1845; and on the 23rd of the same month, for London and Liverpool,—for New York on the 26th July, 1845, and reached that city on the 10th August; left New York on the 30th August, and reached Liverpool on the 15th September. This vessel and her machinery may be considered as a great experiment, from which useful results may be expected. She has already made two voyages across the Atlantic; and, notwithstanding the prognostications of many as to her failure, according to the report of her able and experienced commander, Captain Hosken, has answered well as a sea-boat. Since then her engines and machinery have undergone certain modifications, and some trifling alterations have also been made in the vessel, which experience has proved to be necessary, and which, from the novelty of the construction, and the great scale upon which the experiment was tried, might have been expected, and for which every allowance should be made. These alterations have improved her materially; and it is greatly to be desired that so much labour and expenditure should be attended with complete success. This gigantic structure, which has had the advantage of Brunel's assistance, is certainly bold, original, and in the right direction; for nothing but proportionable mass, power, and correctness of form, are calculated to contend with the heavy swell and gales of the Atlantic. It is by these and other well-conducted experiments, that we may look forward with confidence, at no very distant period, to the voyage between America and Europe, much as it has already been shortened, being still further reduced. The same may be said of the voyage between India and Europe, the importance of which cannot be too highly estimated.

The advantage of steam, as an auxiliary to sailing vessels in long voyages, the steam power being only applied in calms, or when the wind is unfavourable, is beginning to be generally felt; and numerous vessels are now being fitted out upon this principle. For this purpose the screw propeller, with the means of taking it out of the water and replacing it when required without stopping the vessel, appears peculiarly well adapted; for whilst it enables the vessel to retain all her sailing qualities, as well as her capability for stowing cargo, it still gives her the advantage of steam power when necessary. The steam power, as it is not intended to be the chief agent, should be compressed into the smallest practicable space, still so as at the same time to give the greatest power: in order to effect this, tubular boilers of the most improved construction and power of evaporation; direct acting engines, in which wrought iron is substituted for cast iron whenever it is practicable, using sufficient steam of a greater density, together with ample stowage for fuel to last for the average probable time that steam power may be required, must be used. By the judicious combination of steam with sailing, the time of long voyages may be materially reduced, and at the same time considerable saving may be effected in the transport of merchandise.

The Electrical Telegraph.—Connected with, and forming a most important adjunct to, the locomotive system of communication, may be mentioned that extraordinary and useful invention the Electrical Telegraph.

The invention consists in directing a current of electricity through a wire or a series of wires connecting together the intended points of communication. The galvanic or electric current may be produced, either by a battery or by employing the natural electric currents of the earth. The telegraph is worked by handles, which act by means of galvanism upon needles attached to the wires at the other end of the telegraphic line, through which the galvanic current is conveyed, and deflects them to points on a dial-plate, having symbols (according to Cook and Wheatstone's system) or letters or numbers to represent the intelligence to be communicated. By this means intelligence is conveyed from one point to another along the line of wires, almost as soon as conceived, and thus, independent of the advantage as a means of conveying intelligence from one point to another unconnected with the railway, it is of great importance in the working of the railway itself, by preventing accidents; or in the event of an accident unfortunately occurring, enabling assistance to be dispatched without loss of time to remedy the evil and clear the obstruction. Several persons claim the merit of this invaluable invention; it is difficult to decide with accuracy upon the claims of priority; like most other inventions, however, it has been perfected by degrees, and each party is entitled to his due share of credit. About the year 1819, Mr. Ronalds, of Hammersmith, is stated to have applied electricity for the purpose of effecting telegraphic communication, and succeeded so far as to complete a current through eight miles of wire. He also employed electricity as a means of communicating motion to a series of wheels. This apparatus, however, was too imperfect to be of much use, but it is evident, that the idea once propounded and partially carried into effect, to a certain extent, establishes Mr. Ronald's claim to the merit of the discovery. In 1830, M. Ampère pointed out the means of deflecting magnetic needles by a current of voltaic electricity, for the purposes of telegraphic communication, and the principles of this discovery have, it is said, been applied to many of the modern electrical telegraphs. The first plan employed was so very complicated, and so liable to get out of order, that it was soon abandoned; but Wheatstone and Cook so completely improved upon it as almost to make it a new invention. Their system consisted of a dial-plate with symbols, to which the deflected needles pointed, when moved by electric agency. At first it was considered that it was necessary that the wires for conducting the current of electricity should be kept entirely isolated in iron pipes; subsequently, however, this was found to be unnecessary. They are now stretched between a series of posts placed at given intervals apart, beside the railway, and a dial apparatus is placed at most of the principal stations, as well as at the termini. The first telegraphic line upon Wheatstone's plan was established, in the year 1839, upon the Great Western Railway, between London and Slough, a distance of 18 miles, and since that time it has been so much improved that it is now generally adopted. It is already complete on the South Western Line between London and Portsmouth, and is being laid down on the North Western and on numerous other lines.

A company, called the Electrical Telegraph Company, has been formed for carrying out the plans proposed by Wheatstone, to whom great credit is due for the perseverance and ability with which he has worked out his system. Bain also claims a right to the invention, and, in addition to the means of electrical telegraphic communication, has invented a mode of printing by it at the same time, thus affording the means of secrecy, and preventing mistakes; for the apparatus being kept locked in a room or box, no one can have access to it but the person to whom the communication is made. Other modifications of the system have been introduced, but hitherto without being extensively employed.

Another valuable application of electricity to engineering operations consists in blasting rock and other materials above and under water. The first effective application of this principle to blasting, may be said to be due to General Pasley, who employed it for blowing up the wreck of the 'Royal George,' sunk at Spithead in the year 1782, and which, by its own bulk as well as the alluvial deposit accumulated round it, formed a serious obstruction in that important roadstead. Pasley, at the request of the Admiralty, undertook to remove it, and commenced his operations on the 29th August, 1839, by sending down divers, in order to ascertain the exact state and position of the wreck; having done this, he proceeded to place powerful charges of gunpowder in water-tight tin cases in those parts of the vessel where they would have most effect, and they were exploded by an electrical current conveyed through them, by means of wires attached to them, and connected with a voltaic battery placed in a boat floating near: the explosions were instantaneous and almost unfailing, and a great effect was produced: in this manner he succeeded perfectly in removing the wreck in about two summers. The same system was afterwards pursued, in removing the wreck of a vessel in the Thames, and is now generally adopted in similar circumstances. It was applied by Cubitt, at Round Down Cliff, for the purpose of removing a large mass of the cliff on the line of the South Eastern Railway, between Dover and Folkestone: the portion operated upon was several hundred feet long, and between 200 and 300 feet high; the charge of powder consisted of 18,000 lbs., disposed in several cells in the line of the intended explosion, and properly tamped with sand: the explosion took place on the 28th January, 1843, and was perfectly successful, removing about 250,000 cubic yards of chalk rock; its success was of great importance to the railway operations, inasmuch as it materially expedited them, and considerably reduced the cost of this difficult portion of the line. This method of blasting upon a great scale is now generally adopted, and enlarges the sphere of operation in this department of civil engineering, as well as in the removal of rocks under water; for which it was used by Rennie many years since. A very successful application of gunpowder, for facilitating engineering operations, has recently occurred in the removal of a number of marl rock shoals in the bed of the River Severn, executed by Edwards, for Grissell and Peto, under W. Cubitt. Martin Roberts also lays claim to the invention; he exhibited his experiments at the Craig Leith Quarries, in March, 1839.

Thompson has proposed to effect the blasting, or rather the ignition of the powder, by means of common electricity, produced by an apparatus enclosed in an air-tight box, so as to prevent the admission of moisture; this apparatus is said to be more simple and less expensive than the galvanic battery.

Clocks.—Connected with the correct working of the railway system, nothing is more important than accurate time-keepers; for upon these depend the regular starting and arrival of the trains, so that one train may not interfere with the other, and collisions be prevented.

The introduction of clocks into Great Britain took place about the year 1288, and, in 1326, Wallingford is said to have constructed a clock regulated by a balance, which was put in motion by weights, but whose action was extremely irregular. The great improvement of the pendulum does not appear to have taken place until about the middle of the 17th century, and the name of the person who first employed it for this purpose is not accurately ascertained. About 1641 Richard Harris is said to have constructed a pendulum clock for St. Paul's church, Covent-garden; however, as Huygens, in 1658, was the first who explained accurately the motion of the pendulum, the chief merit of its application to clocks may be attributed to him. The application of the spiral spring to the balance is due to Hooke in 1658; and the introduction of the compensating mercurial pendulum by Graham, in 1715, was the next great step in improvement; by means of this valuable invention, the unequal expansion and contraction of the pendulum from change of temperature, which rendered impracticable the accurate measurement of time, was obviated. Graham also suggested the idea of employing different metals, having different properties of expansion, so that the one should neutralize the other; his idea was afterwards carried out by Harrison, in the construction of the gridiron pendulum. For the going fusee, the compensation curb, and other improvements, he received a Parliamentary reward.

The scapement, which communicates the sustaining force to the pendulum or balance demands the greatest skill and accuracy, and various forms have been attempted; amongst others may be mentioned the original scapement-wheel, with its teeth at right angles to the plane of the wheel; the anchor scapement, invented by Clement in 1680; which was improved by Graham, so as to render it more isochronous; the duplex scapement, which does not require such extreme accuracy in the teeth, whilst at the same time it performs equally well; the detached scapement, by means of which the teeth of the scape-wheel always rest on a detent, except when it is unlocked to impel the pallets, is employed in chronometers where great accuracy is required; these, and many other improvements too numerous to mention, are worthy of notice.

The art of clock or watchmaking, termed horology, may be said to be principally composed of four parts. 1. The moving power, which is generally a weight for clocks or fixed timekeepers, and a spring for watches or moveable timekeepers; in the former case, the line suspending the weight should be equal throughout its calibre, and the cylinder on which it is coiled should be true; in the latter case, the form of the spring should be such that its force may act as equable as possible. 2. The scapement, which communicates the sustaining force to the pendulum or balance: the construction of this demands great skill; there are various kinds, the common crown wheel, the anchor, the duplex, the detached, &c. 3. The means of communicating the power to the minute, seconds, and hour hands, which is effected by a series of wheels nicely proportioned and adjusted to each other, having many of the axes or centres working upon diamonds or rubies, to reduce the friction and diminish the application of oil, which is objectionable on account of its being acted upon by the temperature. 4. The regulator, which is effected by a pendulum in clocks and by a balance in watches. The striking (being merely a secondary part), is easily effected, when the other great points have been determined. The perfection of the art consists in the proper proportions, adjustment, and adaptation of the various parts to each other, and the combination of the several improvements above described; this has now been so completely attained that time can be marked so as not to vary the fraction of a second in a day: for these important and valuable improvements in this useful and indeed indispensable art, in England, we are indebted to Wallingford, Huygens, Harrison, Graham, Hooke, Cumming, Mudge, Ellicott, Sutherland, Earnshaw, Arnold, Vulliamy, Dent, Frodsham, Parkinson, French, Kater, and others.

Mineralogy and Geology.—Mineralogy, geology, and mining may be said to form an important branch in the profession of a civil engineer. Without some knowledge of these, the engineer will, in many cases, find himself unable to carry on his operations with that degree of certainty and economy, which is necessary to ensure success, and independently of their value in this respect, there are few departments of knowledge which have contributed more to the advancement, comfort, and civilization of mankind; whilst on the other hand, no class has contributed more to the advancement of them than the civil engineer, so that each department is essentially allied to and dependent upon the other. Geology enables the engineer to obtain a proper knowledge of the various strata through which he has to carry his operations; if for a cutting or embankment of a railway, it is essential to know the slopes at which the earth or rock will stand, the value and applicability of the materials excavated for his bridges, culverts, and viaducts, and their capacity for water, &c., in order to form a correct estimate for working through them, whether for his cuttings or his tunnels. If for a canal, the same will apply, with the addition of the knowledge of the sources from whence his supply of water can be obtained: this latter will also apply to waterworks, in which the knowledge of the various qualities of water applicable to the economy of mankind is so essential. In the construction and maintenance of harbours, it is most important to have a thorough knowledge of the geological strata, and of the nature of the coasts where the harbour is to be situated, in order to render it easily accessible to vessels, whether for commerce or refuge, for its construction in the most economical manner, or for its maintenance, in order that the alluvial matter held in mechanical suspension by the adjacent waters shall not fill it up when made. In the management and improvement of rivers for drainage and navigation, in order that they may carry off the superfluous waters from the low lands and marshes, and at the same time maintain the channels in the most efficient state for navigation. In the formation of embankments against the ocean, in order that nature herself may be rendered subservient, as far as is practicable, in affording the requisite protection; in these as in the operations of smelting the minerals of the precious or the more useful metals, geology and mineralogy are of essential service to the engineer and deserve his peculiar attention.

Mining appears to have been known and practised in Great Britain from the earliest periods of our history, for the Carthagenians are said to have conveyed tin to Tyre, from Cornwall; but in those early days the operations must have been rude, and merely confined to the surface. This invaluable art made little progress until the knowledge of chemistry, and the invention of machinery, enabled mankind to extract from the bowels of the earth Nature's rich treasures, to investigate their different properties, and to apply them to the purposes of life; the steam-engine, which enabled the miner to extract the water and enlarge the field of his operations has been of invaluable service when the ore was raised from the mine, as also aiding in its reduction and the extraction of the metal in its most refined state. Some of the Cornish mines have been extended to a depth of more than 220 fathoms below the surface. As regards coal-mines, they also have been worked to an extraordinary extent, as in the case of the Cumberland coal-fields, which have been wrought above a mile beneath the sea. The total quantity brought to the surface and consumed annually amounts to between 30,000,000 and 40,000,000 of tons. Without the steam-engine these operations would be entirely paralysed, and must cease. The total annual value of the British mineral produce is said to amount to about £26,000,000. In this valuable department we are much indebted to the establishment of the Museum of Economic Geology, which will be the means of extending the knowledge and use of minerals, as well as the best mode of obtaining them. Neither must we forget the valuable services of Sir H. De la Beche, Murchison, Sedgewick, Greenough, Buckland, Horner, Lyell, John Taylor, Griffiths, Buddle, Sopwith, Philips, Wood, Atkinson, Bald, and others, who have contributed so largely to the advancement of this important branch of science.

Ventilation.—Connected with mining may be mentioned the important subject of ventilation, the value of which is now so universally appreciated, not only for mines but for public and dwelling-houses. The art consists in conveying volumes of fresh air through apartments, so that the air shall be always as nearly as practicable in the proper state for respiration; but in effecting this, it is desirable that the temperature shall not be reduced too low, otherwise inconvenience may be produced in other respects; whilst ventilation, therefore, is of great importance, the artificial warming of apartments is of equal consequence, and to combine both effectually is the great desideratum. Heat is the great medium for producing circulation, as in the example of collieries and mines, and on extraordinary occasions mechanical power may be applied. The common fire-place is the most wasteful of fuel, but possesses many advantages; and, although the stove may produce a more equable temperature, a proper combination of both seems best adapted to unite the advantage of a thorough circulation of air with the required degree of temperature; warm water and steam conveyed through pipes have been employed in many cases; those systems are however the best whereby a large body of air is raised to about 100° by passing between cases filled with hot water, and is enabled to flow freely into the apartments, expelling at the same time a corresponding bulk of vitiated air; thus rendering ventilation an integral portion of the system of warming; by such a plan, warm water may also be supplied to any part of the building for domestic purposes. When stoves are used, they should be upon the principle of slow combustion, and be so contrived as to avoid producing any disagreeable odour; for this reason porcelain is much employed, and it is essential to have a thorough circulation of pure air where stoves are employed. Upon this important subject, much information has been elicited by the late Parliamentary Reports, and by the labours of Sylvester, Tredgold, Arnott, Reid, Hood, Price, C. Manby, Perkins, Haden, Stephenson, and others.

Architecture.—The pursuits of the engineer are intimately connected with architecture, not merely as regards construction, but in taste also; and, although it is not necessary that he should be so thoroughly conversant with all the details of ornament, as to be able to practise as an architect, still he should be so far acquainted with them as to be able to carry out the leading principles with effect, whenever it becomes absolutely necessary in the course of his practice. The works of the engineer, associated as they are for the most part with the great operations of nature, should be designed and constructed so as to harmonize with them. They must strike by their general mass and proportion rather than by trifling details or minutiæ of ornament, which as a matter of taste, would be misplaced and unnecessary, and wasteful as regards expenditure; consistently, therefore, with their first grand object of fitness for their purpose, they should be simple, and in the few instances where ornament may be necessary, it should harmonize with the structure and be sparingly used.

In architectural masonry, the ancients have left us admirable models which cannot be too much studied, and may be generally followed with great effect and advantage; but the adaptation of timber and iron to modern architecture requires a different treatment. The massive proportions and dimensions which suited well the character of stone are no longer necessary, and would be misplaced when applied to the more solid and tenacious properties of iron; here equal strength is obtained with much smaller dimensions, which, at first sight, from their lightness and apparent weakness (until the eye becomes accustomed to them), produce a feeling of insecurity which can only be overcome by time; but this feeling soon vanishes, and the great convenience, economy, and security introduced by the employment of wrought and cast iron, has caused it to be generally adopted whenever practicable. In order, however, to ensure success, great care must be taken in the selection of proper materials for its different applications, and much depends upon the mode in which it is manufactured; the right understanding of this and of the different processes of converting the ore into the several states of cast and malleable iron and steel, all of which possess very different properties, and require different proportions and dimensions in their application, demands no ordinary skill and experience. The application of heated air for the purpose of reducing iron from the ore (commonly called the "hot blast" system, invented by Neilson, in 1826), has produced a considerable revolution in the character of the metal, as well as in the economy of manufacturing it, and the comparative merits of hot and cold blast iron is still a subject of controversy, which requires to be duly considered in its application to construction. Cast iron, from the rigidity and brittleness of its texture, is not so well adapted to resist concussion, or any sudden strain, as wrought or malleable iron, and when employed, it is necessary to make greater allowance to meet it; hence the employment of malleable iron has become more general, and has, in many cases, superseded the use of the former, as while it contributes equal strength with less weight, it gives warning previous to fracture, and enables a remedy to be applied, which cast iron does not; for these reasons it is now almost universally employed for all purposes where it is required to resist tension and sudden irregular strains, and to combine strength and lightness; whilst cast iron is only used to resist compression, and to counteract by its mass and rigidity any tendency to movement or alteration of form. By thus carefully studying the different properties of both materials we soon acquire a knowledge of the best mode of adapting them to their different purposes, and giving to them those architectural forms best suited to their respective qualities and the objects for which they are employed. One of the great advantages of wood consists in the first economy and the facility of converting it to the several purposes where it can be employed, and hence, until the properties of iron and the mode of working it became better understood, wood alone was used in conjunction with stone and brick, both for engineering and architectural purposes, and notwithstanding it has been altogether superseded for many purposes by iron, nevertheless it still possesses advantages in the construction of bridges, roofs, and other works where the first outlay of iron or stone would be too great. Enough, I trust, has been said, to show the intimate connexion of the professions of the civil engineer and architect, and, without the one usurping the province of the other, it is much to be desired that a harmonious understanding should be cultivated between them, as it must tend to their mutual advantage, and nothing can contribute to this desirable object more than the meetings of this Institution, to which it is gratifying to find so many architects have attached themselves.

Agriculture.—Neither must we forget the comparatively recent adaptation of engineering knowledge to the advancement of agriculture, and the various implements connected with it, for ploughing, drilling, threshing, grinding, &c. Since the improvement in the working of iron, the machines for conducting these various operations are constructed with a degree of portability, economy, and efficiency which render them of the greatest importance to the farmer, and enable him to cultivate the soil, as well as to convert its various products to domestic purposes, in a much more economical and expeditious manner, than formerly, and to derive a greater profit from his exertions. In the construction of agricultural implements, Messrs. Ransome, May, Cottam, Stratton, and others, have greatly distinguished themselves.

In modern agriculture, under-draining forms an important and valuable principle; stagnant water generally has been proved to be injurious to agriculture, and it is, I believe, now universally admitted that without thorough drainage it is impossible to cultivate the soil effectually; for this purpose small drains formed by tiles laid from 1 foot to 4 feet below the surface, are generally adopted; the tiles are made by machinery invented by the Marquis of Tweedale, Ainslie, and others at a trifling cost; the surface water is thus conveyed from the land into the adjacent main drains and thence to the rivers. Water is the grand natural fertilising agent, and any amount of care in its proper distribution is well bestowed: it is, therefore, worthy of consideration, whether in hilly countries and districts subject to alternations of dry and wet seasons, it would not be advisable to establish large reservoirs for water, to be used during dry seasons for irrigation, in the manner adopted by the ancients; by this means districts might be cultivated with advantage, which now are comparatively sterile. Artificial irrigation is now much practised, and the extensive water meadows of the Duke of Portland near Welbeck are well worthy of notice. In this essential department, Smith, of Deanston, Parkes, and others have made considerable progress, and the scientific researches of Davy, Brande, Buckland, Liebig, Johnston, Gardiner, Philips, and others, under the patronage of the Royal Agricultural Society, which includes the names of the most distinguished nobility and gentry in the country, have contributed materially to the advancement of agriculture; and since the public attention has become alive to its importance, and means suitable to the end have been devoted to its improvement, there can be little doubt but that its future progress will be in a ratio commensurate with it.

Surveying.—Land and maritime surveying form an essential department in the profession of a civil engineer; without a correct knowledge of the former, it is impossible for him to lay out and determine in the best manner the proper lines of communication in a district, whether by canal, railway, or common road; and without a knowledge of the latter, it is equally difficult for him to decide upon the best situation for a port, and the most advisable means of improving and maintaining it. In these valuable departments much progress has been made. The great Trigonometrical Survey of the British Islands, which is now very nearly completed, is the greatest work of this kind ever undertaken in this country, and serves as a model for minor works of this nature. It was commenced by General Roy in the year 1783, under the direction of the Ordnance Department of the Government, and has been subsequently carried on, with equal ability, by General Mudge and Colonel Colby, of the Royal Engineers, under whose direction it now is. This great work, so far as it has proceeded, has already proved of essential service to the civil engineer, inasmuch as all the towns and villages, the chains of hills, valleys, and rivers being laid down trigonometrically, his labours, as well as the expenses of his employers, are materially diminished, in tracing out the best lines for railways or other internal communications; instead of having to survey the whole district of his operations trigonometrically, he has only to take the leading points, and to fill in the detail of fields, buildings, &c., to a larger scale; and even before incurring this labour he can, with one of the Ordnance maps in his hand, determine in a great measure the general direction and course of his line; notwithstanding this, it is essential for him to have a thorough knowledge of the use of instruments, the theodolite, sextant, and transit, the most accurate mode of measuring bases, and to see that those employed under him are competent to their task, and employ the necessary means to ensure accuracy in their surveys. Connected with surveying, we must not omit the important department of levelling, for simple as it is, nothing requires greater accuracy, in fact upon this being properly done the success of the whole scheme or undertaking in hand may be said mainly to depend; too much attention, therefore, cannot be paid to it, the instruments employed should be of the best construction, simple and substantial, easily adjusted, and kept in good order; the levels should be referred to one datum and proved in various ways, and recorded in a plain intelligible manner, so that they may at all times be easily referred to.

Maritime surveying requires an intimate knowledge of the general laws which govern the tides, the set of the currents, the prevalence and direction of the winds, the soundings, anchorage ground, &c.; these should be regularly observed for a given period, in order to ascertain every possible variation, and regularly registered and referred to the same datum. For this purpose, self-acting tide-gauges, with a clock apparatus attached to them, for marking the time of high and low water, if placed in proper situations, are extremely valuable: that at Sheerness Dockyard, by Mitchell, and the improved one at Ramsgate Harbour, are worthy of remark.

Mineral or underground surveying differs only from the above in its being necessary to ascertain the dip or angle at which the several strata lay, their general direction and thickness, their quality and value, and the best mode of working them. For laying down the underground survey, the magnet and circumferenter are much employed.

In the investigation of the laws which govern the tides we are much indebted to the valuable scientific researches of our honorary members Lubbock, Whewell, Airy, and others. Connected with the various branches of surveying, the construction of philosophical instruments is entitled to an important station; as without accurate instruments it is impossible to make correct surveys, and for the construction of these we are much indebted to the labours of Ramsden, Troughton, Dollond, Carey, Simms, Watkins, Jones, Elliott, and others.

Drawing.—Drawing and modelling, although minor, form valuable, and, in fact, indispensable departments in civil engineering; for unless the various projects proposed to be carried into effect, are in the first instance correctly delineated upon paper, it is impossible to convey a just idea of them, or to form a correct estimate of the cost. Drawing may be classed under three heads:—mechanical or geometrical drawing, is that whereby the plans and sections are simply represented as they would appear on a plane surface; perspective drawing consists in representing the objects as they appear when seen from a given distance and height; this kind of drawing, although very useful, and indeed indispensable, to the architect, in order to represent the true effects of light and shade of his different compositions, as they would appear when carried into effect, and upon a true perception of which, the success of his building will mainly depend, is not of that importance to the engineer, whose works are of a different kind, and much more extensive, so that to represent them perspectively would in many cases be impracticable; but inasmuch as in detached portions of his works, such as important bridges, viaducts, machinery, &c., perspective drawing may be employed with great advantage, it ought to be studied. Landscape and topographical drawing is also useful, in order to convey to unscientific persons an idea of a particular locality, in the manner they are accustomed to view it, where works are proposed to be executed, and thus to remove fancied objections which otherwise might be overcome with difficulty; and this is still more successful with the application of colours when applied as seen in nature. These different kinds of drawing should be carefully studied and practised with accuracy, as they will be found essentially to forward the views of the engineer, and give satisfaction to his employers.

Although drawing, however, is most valuable, modelling in many cases is essential; for in the former case the objects are merely represented upon paper, assisted by light and shade and perspective, which to persons in some measure acquainted with the subject conveys a tolerably correct idea of what is proposed to be done, but a model represents it (although upon a reduced scale) exactly as it is intended to be, with the different planes, dimensions, and surfaces; hence, nothing, except the work itself, gives such a perfect idea or representation as a model; it also enables the engineer to detect many imperfections which otherwise would escape his notice; whenever, therefore, models can be conveniently adopted or employed, it is advisable to do so; and it is gratifying to know that the art of modelling has made considerable progress, so that now they can be obtained at a moderate cost in wood, card-board, plaster, and clay, and will thus be more generally employed. In this department Salter, Deighton, Day, and others have attained deserved celebrity. Working models of machines are extremely useful to give an idea of the action of a machine, but we should be cautious in drawing conclusions from the results, for it too frequently happens that a machine succeeds extremely well when tried in a model, but fails when put in practice; we should, therefore, merely consider the results of working models as guides to be worked out practically, and in this way they are extremely useful.

Meteorology.—The principles of this science, as far as they have yet been determined, claim our particular attention. Without a knowledge of the winds, and the quantity of rain falling in a particular district, we cannot determine with precision the proper form and dimensions of moles or piers to resist the action of the sea, or of drains to carry off water from extensive districts of marsh land, or of the extent to which it may be necessary to improve the channels of rivers; or in carrying lines of railway through a country, to design the works in such a manner that they may withstand the shocks of the elements; neither can we select the proper kind of stone or other materials for constructing buildings, unless we know the vicissitudes of climate to which they may be exposed, or the extent to which they may be acted upon by it. In the investigation of the phenomena of this difficult science, we are much indebted to the late Professor Daniell, and to C. H. Smith, whose report upon the qualities of the different kinds of stone, as regards their tenacity, hardness, capability of resisting moisture, and durability, for the purpose of selecting the best material for the new Houses of Parliament, forms an important and useful example, for which the engineer and the architect are much indebted, and the same course should be followed, as far as is practicable, previous to commencing every great work, and indeed for the want of it we find now many magnificent buildings partially decayed which otherwise would have been in good preservation.

Patents.—The improvements in manufactures, machinery, and other branches of art, resulting from a great number of curious and valuable inventions, necessarily gave rise, on the part of the successful inventors, to a desire to secure for themselves and their posterity, as far as is practicable, the benefits of their labours. The Government, perceiving and duly appreciating the advantages which not only the inventors themselves, but the nation at large, derived from them, wisely resolved to give every possible encouragement, by securing to them the exclusive right and title to their inventions for a certain number of years, and to enable them to recover by legal process, severe penalties, against any person attempting to use their inventions, without the previous consent of the inventors themselves. Hence arose the Law of Patents, or a privilege of the Crown to grant Letters Patent, conveying to the persons mentioned therein, the sole right to use or dispose of any new invention or discovery for a limited period, which is generally about fourteen years. It is difficult to fix the date of the first assertion of this privilege of the Crown, but it was first defined by statute in the reign of James I. The law has at various times undergone certain alterations and modifications, so that it now forms a branch of itself, which, with its various complicated relations, demands a peculiar study. Ever since the reign of Anne, parties have been compelled to specify in detail the particulars and nature of their invention or discovery, previous to being able to obtain Royal Letters Patent. The great number of inventions, which have multiplied considerably of late years, has given rise to an important class of professional gentlemen styled Patent Agents, who devote themselves exclusively to the study of inventions and the peculiar laws relating to them, in order to secure to inventors their just rights and prevent them from being infringed upon by others. Amongst these gentlemen we may mention the names of Robertson, Newton, and others, to whom inventors are much indebted for the skill and attention with which their interests are guarded, as also to Godson, Holroyd, Hindmarsh, Rotch, Webster, Farey, Carpmael, and others, who have devoted themselves to the study of the Patent Laws, and have written ably upon them.

Theory and Practice.—In the preceding pages, my remarks have been almost exclusively confined to the notice of the various works which have been carried into effect by civil engineers since the time of Smeaton; and although practice, upon the whole, is most important, nevertheless, we should not omit the study of the theory, or principles upon which that practice is, or ought to be, founded, and without the due study and comprehension of which, we may frequently be led into great errors in practice. Our junior members should, therefore, previous to commencing their professional career, be well versed in arithmetic, algebra, mathematics, mechanics, and the principles of natural philosophy in general, and the mode of applying them to practice. They should cultivate a patient and equable temper of mind, in order to enable them to investigate, with rigid impartiality, the principles so beautifully illustrated in nature, and upon which the great operations which may hereafter be intrusted to their charge as civil engineers depend; and once having found out, and thoroughly understood these principles in all their various applications, they should never depart from them, always bearing in mind, that nature will submit to assistance and guidance for the benefit of mankind, but never to opposition with impunity;

her laws are immutable, and we may be assured that, either for good or evil, the same causes will produce the same effects; if, therefore, we wish to command success, we must adhere to her laws, and when once we thoroughly understand them, we shall be amply rewarded for all our toil; difficulties will vanish, and success will invariably attend our efforts. Previous to commencing practice, our junior members should not neglect the workshop; on the contrary, it would contribute materially to their advancement to undergo an apprenticeship of some years in that department; for inasmuch as the success of many of the works in which they may hereafter be engaged, particularly the mechanical, depend in a great measure upon the correct application of the principles which can be only thoroughly learned in the workshop, that is the place in which they must be studied; moreover, it will imprint indelibly in their minds, the principles which they acquire from books, and induce a degree of accuracy of thought and execution which cannot be acquired elsewhere; hence we find that some of our greatest engineers, both of the past and present age, have there acquired a considerable portion of their education, and owe a great degree of their celebrity, to that invaluable nursery for engineers. Nothing, therefore, can be more erroneous than to suppose that theory and practice are incompatible with each other, for they are intimately connected with and dependent upon each other. Without a thorough understanding of the theory or principles upon which engineering is founded, it is impossible to carry them into practice without endless failures and wasteful expenditure of means; and without the experience derived from practice, the principles acquired from theory will be of little avail; both therefore must be carefully studied and combined in order to produce a good engineer. Finally, composition, or the art of putting ideas into simple, clear, and intelligible words, should be studied, in order to convey to the world just notions of the measures proposed; also an intimate knowledge of the value of materials and workmanship, in order that he may be enabled to make correct estimates, upon which the success of all commercial undertakings so materially depend.

Continental Engineers.—In making the foregoing remarks, I have endeavoured to confine myself strictly to what has been done by civil engineers in England during the past and present centuries; but in so doing I should be extremely sorry to be considered as detracting from, or underrating in the least degree, the great merits of continental engineers, or the progress which has been made by them also during the same period, and we are proud to number many of them among the members of this Institution. To attempt to enter upon this equally interesting as instructive subject, would compel me to trespass much longer upon your patience, which I fear has been already tried too much, but I cannot omit remarking, that the greatest credit is due to our professional neighbours on the Continent, for the example which they set in the infancy of the science, when it was so little known in this country, and for the great progress which has subsequently been made, and the numerous inventions which have emanated from them. In Italy, we have only to mention the harbours of Genoa, Venice, Ancona, Civita Vecchia, Leghorn, and Naples; the canals and silk machinery of Lombardy; and the names of Leonardo da Vinci, (said to be the inventor of the pound lock,) Gugielmini, Frisi, Manfredi, Martinetti, Fazio, Miliani, and numerous others. In France, the mole and docks of Cherbourg, Toulon, Brest, Havre, Boulogne, Calais, and Dunkirk; the canals of Languedoc, Burgundy and Picardy; the embankments of the Loire; the bridges of Neuilly, Bordeaux, the Dordogne; and the names of Belidor, Papin, Gauthey, Rondelet, Dupin, Perronet, Prony, De Cessart, Lambarde, Reibel, Sganzin, Frissard, Hallette, Navier, Jacquard, and others. In Switzerland, the Alpine roads of the Stelvio, Mont Cenis, St. Gothard, the Splugen, the Brenner, the Simplon, &c. In Holland, the magnificent embankments for defending the country from the sea; the great Texel, and numerous other canals. The system of drainage, although perhaps too complex and artificial, is also meritorious and worthy of remark. Throughout Germany, the system of managing the great rivers Danube, Rhine, Elbe, the bridges across them, the canals connecting them together, as well as the roads and mining operations. In Sweden, the docks of Carlscrona and the Trohlhatta canal; and in Russia, the docks at Cronstadt and Revel, the extensive inland navigation, roads, &c. In Spain, the moles of Malaga, Alicant, Tarragona, and Barcelona; the docks at Ferrol, Carthagena, and Cadiz, and the Arragon canal; and the railway system, which owes its origin to this country, is now making rapid progress everywhere on the Continent. Neither must we omit to notice the ingenuity and vigour of our transatlantic brethren, the United States, to whom the world is much indebted for their many splendid public works and useful mechanical inventions and discoveries.

I have thus endeavoured to take a rapid survey of the different departments which constitute the profession of a civil engineer since the commencement of the last century, or, rather, from the time of

Smeaton, down to the present day. Imperfect, however, as this survey has been, I fear it has trespassed too much upon your valuable time, although the interest and importance of the subject justly entitle it to an extended notice, and would amply repay the perusal, if it had been treated by an abler hand, at even much greater length. Looking back to the humble goal from which we started, a little more than a century since, and then adverting to the exalted pinnacle upon which we now stand, what almost immeasurable space have we traversed—what triumphant progress have we made! In how great a degree have both public and private prosperity, and the civilization of mankind, been promoted by it. Within a few years our profession was comparatively unknown, and the great and beneficial results which have sprung from it were never anticipated; now it is universally in the ascendant, and it may be so with reason, for without presuming to undervalue the merits and importance of other professions, that of the civil engineer may be said to embrace everything which can tend to the promotion of the comfort, the happiness, and the civilization of mankind, and to be founded upon principles of the highest order.

Comparatively speaking, only a few years have elapsed since Great Britain, as regards engineering works, was in a very backward state: she had neither roads, canals, harbours, machinery, nor manufactures worthy of being compared with those of her neighbours on the Continent. Let the comparison be made now, and we find that if we do not surpass every other nation we are inferior to none. And to what may this extraordinary change be attributed, but to the progress of civil engineering? Notwithstanding, however, we have advanced thus far, much still remains to be done. Great as has been the result, we may be said scarcely to have passed the threshold of improvement. It is true we feel the influence of our position, but this can only be maintained by further advancement. To stand still is to retrograde; our career must be onward; and what has been done should only serve as a stimulus to greater exertions. We have still a very wide field before us; let us, therefore, by our united exertions, cultivate it to the very utmost; let us never rest satisfied so long as anything remains to be done.

Much yet remains to be discovered in the formation, construction, and maintenance of harbours, in order to afford the greatest facility of ingress and egress under all circumstances, without at the same time diminishing the necessary protection and depth;—in the improvement of rivers, so as to enable them to drain and carry, off the floods effectually from the adjacent marsh-lands and valleys, and at the same time to render them capable of navigation to their utmost extent; to point out the most effectual means of enabling them to discharge their fresh waters into the sea or estuaries, and to receive the tidal waters without causing them to deposit the alluvial matter held in suspension by their waters, in such a manner as to form injurious bars or shoals;—in determining the best form and construction of vessels, so as to render them capable of giving the least resistance in their passage through the water, and conveying the greatest burthen or cargo with the utmost safety and velocity;—in determining the best form, dimensions, and construction for locomotive-engines for any gauge, so as to combine the utmost capability of producing steam, with the least quantity of fuel, and drawing the maximum load with the greatest velocity, combined with the greatest safety and economy;—in determining the proper width of gauge which shall satisfy all the required conditions of safety, economy, and speed;—in determining the most expeditious, safe, and economical means of transferring goods, passengers, and carriages from one line to another, whenever a break of gauge becomes necessary;—in determining the best and most economical mode of constructing and laying down the permanent way, in such a manner as to enable the trains to travel with safety, at the greatest speed the engines are capable of producing, with the least wear and tear either to the permanent way or to the engine and carriages;—in determining the resistance of railway trains; in devising means for obviating the leakage by the valve in the atmospheric system; in discovering a substance for sealing the valve which shall preserve the desired consistency under all degrees of temperature; and in generally investigating that system of traction, in order to remedy any practical defects which may exist, and to ascertain when it may be applied with the greatest advantage; in the improvement and adaptation of machinery to many new objects in the arts and manufactures, and in the application of chemistry and geology to our operations. These, and a variety of other improvements, are to be desired, and worthy of our particular attention and study. The steam-engine itself, improved as it is, and wonderful as have been the results produced by it, is capable of further improvements. Its bulk and weight may be further diminished, both in the form and construction of the boiler as well as in the engine itself, and thus, in effect, its power may be increased; or it may be reserved to us to discover the means of producing and rendering subservient to our purpose some other power which shall surpass steam, or, perhaps, to substitute for it that all-powerful agent electricity, which Jacobi has already attempted to apply to navigation. Obscure and difficult as the subject may appear now, it may still be realized. Our indefatigable and enlightened honorary member, Faraday, has pointed out the way, and is still proceeding in his distinguished career with remarkable success, and we must not lose the opportunity of profiting by it: in fact, by well-directed and combined exertions, it is impossible to foresee the results which may yet be arrived at.

This Institution, which but a few years ago was scarcely known, has now taken its station amongst the first scientific societies of the kingdom; and as its objects are second to none in importance, whether as regard their public or private utility, so must it continue to flourish and increase in importance if those objects be only legitimately and steadily prosecuted. In order to effect this we must not relax in our exertions, there must be no schism among ourselves; the Institution must be our rallying point; we must all work for the common good. We must contribute to its advancement, as well as that of our profession, by every means in our power—whether by papers by verbal discussions, by contributions to the model-room or the library, or by the construction of works which shall serve as examples worthy of being followed—in fact, in every practicable manner, each according to our several opportunities.

Let the senior members, both by their precept and example, and their forbearance, courtesy, and assistance towards each other, with liberal and right-minded zeal, for the honour of themselves and their profession, point out to the junior members the true road to eminence; and as they, by the common lot of mortality, must quit this transitory scene, let them be succeeded by others fully competent to fill their places, and to enlarge the boundaries of their profession.

On the other hand, let the junior members look up to their seniors as friends, and as sure guides to follow, and from whom they may with confidence seek for assistance in the hour of need; and, banishing all jealousies or other ignoble feelings, let them rally round and support their seniors under all circumstances. Let the chair of this Institution be an object of honourable ambition to the youngest Graduate, as a goal to which he may look forward as one of the rewards, and that not the least, of his successful exertions in his professional career.

By thus pursuing steadily, and with one vigorous and united effort, this grand object—the elevation and advancement of the profession—we shall have the proud satisfaction of finding that our exertions will be crowned with success; that the Institution, as well as ourselves, will flourish; and, what is a far nobler achievement, we shall find that by removing, or, at least, diminishing, as far as may be practicable, all physical obstacles by sea and by land to the free communication of nations with each other, and by the invention of new machinery, or other means, to supply their mutual wants, we shall ultimately understand our true interests. Prejudices and national jealousies will vanish, and instead of exterminating each other by that greatest curse of mankind—war, we shall become bound to each other by the ties of peace, and united like one great family, striving together for the benefit of the human race.

London: Printed by William Clowes and Sons, Stamford Street.

HEALTH OF TOWNS ASSOCIATION.

REPORT

OF

THE COMMITTEE

TO THE

MEMBERS OF THE ASSOCIATION,

ON

LORD LINCOLN'S

SEWERAGE, DRAINAGE, &c., OF TOWNS' BILL.

LONDON:
CHARLES KNIGHT & Co., 22, LUDGATE STREET.
1846.

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HEALTH OF TOWNS ASSOCIATOIN.

REPORT OF THE COMMITTEE

TO THE

MEMBERS OF THE ASSOCIATION,

ON

ORD LINCOLN'S SEWERAGE, DRAINAGE, &c., OF TOWNS' BILL.

Lord Lincoln's Bill.

YOUR Committee, having directed much of their attention to the medial measures necessary to the improvement of the sanatory condi- on of the country, have thought that they could not better promote e main object of the Association than by a careful consideration of e provisions of Lord Lincoln's Bill, and by embodying in a Report you the result of their examination.

2. It is presumed that this Bill contains the expression of the matured pinion of the Government as to the remedies which it deems expe- ient to propose to the legislature for the removal or the mitigation of rils which it is now admitted are universal in their extent, and de- ructive in a great degree of the comfort, the morals, the health, and ven the life of large classes of the people. It is of the last importance hat the measures proposed to the legislature, with a view to put a stop o these evils, are really calculated to accomplish the object; that they o not in any instance consist of expedients which experience has lready proved to be inefficient; and, above all, that they do not even ppose new obstacles to the practical introduction of economical and ffectual remedies.

Sanatory Reports.

3. Your Committee willingly avail themselves of this occasion to xpress their sense of the value of the able Reports presented to the gislature and the public on this subject; first of all by Dr. South- rood Smith and Drs. Arnott and Kay, acting under the Poor Law ommission, who in the year 1838 first directed attention to the eplorable condition of the districts of the metropolis inhabited by the

poorer classes, and to the ravages of fever and other fatal diseases in these localities; next by the Committee of the House of Commons, which followed up these inquiries in the year 1840; then again by Mr. Chadwick, who, also acting under the Poor Law Commission, having carried on still more extended investigations during the years 1840 and 1841, presented the results in the Sanatory Report of 1842; and lastly, by Her Majesty's Commissioners appointed in the year 1843 "to make further inquiries into the actual state of large towns and populous districts, and to devise the best means of promoting and securing the public health."

Result of Sanatory Inquiries.

4. The result of these various inquiries has been the collection of a body of evidence of the highest order, relative both to the extent and intensity of the evils in question, and to the proper legislative remedies; and the publication of this evidence will, in the opinion of your Committee, form an era in the history of legislation, there being no other instance known to them in which evils of so much magnitude have been proved to be so generally prevalent; in which the search after efficient and permanent remedies has been attended with a success so unquestionable and so unquestioned; in which the mode of giving practical effect to those remedies has been so satisfactorily shown; and consequently, in which so much has been done at once to guide the legislature, and to instruct and prepare the public mind for cordial co-operation with it.

The Bill introduced into Parliament at the close of the last Session by Lord Lincoln, is based upon the evidence derived from these sources and more especially upon the recommendations of Her Majesty's Commissioners. It contains internal evidence of great care and labour bestowed upon the preparation of it. It indicates in many instances a sincere and earnest purpose to carry out the recommendations of the Commissioners; several of its provisions are coincident with those recommendations, and upon the whole your Committee cannot but regard it as a great improvement on any former attempt at legislation on this subject and as forming an excellent basis for a comprehensive and efficient sanatory measure.

Sound Provisions of Lord Lincoln's Bill.

5. The most important provisions of this Bill appear to your Committee to be the following, viz:—

That the supply of water, the sewerage, the drainage, the cleansing, and the paving of towns should all be under one and the same authoity. That the whole of a town, including the suburbs, and the whole f the drainage area, should also be under one and the same authority. hat the interests of the community should be protected by the supervision of a competent, impartial, and responsible public officer, named n Inspector. That before new works are undertaken, full and comrehensive surveys should be made by competent engineers. That lans of complete works should be prepared by responsible public fficers, or locally examined by them with the estimates. That expoitory reports should be drawn up for local publication, in order that he advantages of new works may be thoroughly canvassed by all arties interested in them. That the whole of the works should be maintained as well as executed by contract. That the performance of he contract should be supervised by a competent, paid, and responsible ocal officer. That certain nuisances which at present poison the tmosphere of towns and deteriorate the physical condition of the opulation, should be suppressed. That to secure the suppression of hese nuisances there should be appointed a public officer, armed with ufficient powers to enforce obedience to the law, called an Inspector f Nuisances; and that the true causes of disease and death should be scertained, and the spread of diseases, and more especially of epidemic diseases, should be checked, by the appointment in districts of a skilled and responsible medical officer, called an Officer of Health.

Practical effect of these Provisions.

6. These provisions are founded on conclusions the soundness of which is demonstrated in the Sanatory Report, and the importance of which is shown at great length, and by a vast variety of additional evidence collected and enforced by Her Majesty's Commissioners. These provisions alone, if passed into a law, will, in the opinion of your Committee, effect, with absolute certainty, a highly beneficial change in the sanatory condition of towns, which will be followed by a proportionate improvement in the physical, and ultimately in the moral condition of the inhabitants, and more especially of the poorer classes. The extreme importance of these provisions renders it desirable that any Act which contains them should in the whole of its details be as sound and complete as the present state of knowledge renders practicable; nor can your Committee avoid expressing their opinion, that any assistance in maturing and passing such an Act which may be afforded by a minister of the Crown will deserve and will ultimately receive the gratitude of the country.

Defects of the Bill.

7. In as far as the proposed Bill carries out the results of the e dence collected by Her Majesty's Commissioners, and is founded their recommendations, it appears to your Committee to be satisfacto but it will be found that, while some of these recommendations of gr importance are not adopted, others are directly contravened.

Limitations of Act.

8. The first point to which your Committee would direct attentio the proposed limitation of the Act; that is, the limitation of its ope tion to England and Wales to the exclusion of Ireland and Scotla and to the further exclusion of the metropolis even of England its Now a large proportion of the evidence on which the conclusions the first and second Reports of Her Majesty's Commissioners a founded is derived from the experience of the metropolis, and t specific recommendations of the second Report are applied directly evils prevalent in the metropolis; while it is universally known a admitted that the towns in Ireland and Scotland are subject to the sa evils as those ascertained to exist in the English towns, only common in greater intensity, and that consequently they stand in still mo pressing need of remedies.

Sanatory Condition of the Metropolis.

9. The wretched condition of the districts of the metropolis inhabite by the poorer classes has now been made public upwards of eight years That the disease and mortality originally stated to be prevalent i these districts have since that time not diminished, but on the contrar have been actually increasing, is proved by the following evidence:—

"Referring to your great and constantly increasing experience," say the Commissioners* to the Physician of the London Fever Hospital, Dr. Southwood Smith, "as to the cause of the prevalence of diseases among the humbler classes, have you observed any alteration or aggravation in the degree of fever of late, as compared with former years?" "The change," replies this witness, "is so great and striking, that I can only express it by saying that it is a new disease. The fever which prevails everywhere in the metropolis now is totally different from that which I was accustomed to see for a long series of years; it is as different in its symptoms, and requires as opposite remedies, as any two diseases in the catalogue of nosology. Whatever may be the cause, the fact is certain, that at the present time an epidemic is prevailing which lays prostrate the powers of life more rapidly and completely than any other epidemic that has appeared for a long series of years.

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* First Report, vol. i. p. 17.

o that attention to the sanatory state of the country, and particularly o the condition of the localities in which the poor reside, at all times nportant to the public safety, is now peculiarly necessary; and is endered necessary by the particularly fatal character of the prevailng epidemic, the rate of mortality being at present unusually high."

This evidence was given nearly two years ago. From the Report f the London Fever Hospital, just published, it appears that during he last year (1845) there was scarcely any part of the metropolis free rom the visitation of fever; that in many instances it attacked and early destroyed whole families; that in one of the cases recorded nine nembers of a family were seized with it, of whom six died; that it is ertain that fever was prevailing in the houses and localities from which he patients were taken in no less than eighty-two instances, and it is robable that this was the case in many more than could be ascertained rom the patients themselves, because some were too ill and others too nobservant to give a correct account of the circumstances connected with their attack.

From the evidence of Mr. Jeremiah Little,* an extensive builder of hird and fourth-rate houses in the metropolis, it appears that "the verage losses on the rent of such houses is one-fifth, and that three ut of the five of these losses are from the sickness of the tenants, who re working men."

Increase of mortality with full employment and high wages.

10. But it is not in the metropolis alone that the intensity and mortality of disease have increased and are increasing. There is indubitable evidence of the same melancholy truth derived from the experience of other towns and cities, in widely different parts of the kingdom. During the last year full employment has been given to the manufacturing population in certain manufacturing towns, at higher wages than were ever before known in these places; yet the Registration Returns show that full employment at high wages has not been sufficient to preserve the population from an increased ratio of sickness and mortality; not that high wages can be supposed to increase sickness and mortality; but the returns clearly show that a high degree of prosperity is incapable of affording protection from disease, suffering, and premature death, arising from the neglect of efficient drainage, proper cleansing, a due supply of water, and other sanatory measures, which are actually extended to the inmates of well-regulated

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* First Report, vol. ii. p. 303.

prisons, and which science might secure to the whole of the populati Thus, from the Returns of the quarter's mortality (the quarter endin the 31st of December, 1845), it appears that in Bolton the form December quarter's deaths were 621, the last quarter's were 822; in Preston, the former quarter's deaths were 429, the last quarter's deat were 522; in Wigan, the former quarter's deaths were 371, the las 402; in Rochdale, the former quarter's deaths were 329, the last 41 in the ill-conditioned town of Bradford, the increase has been from 83 to 1039; in Sunderland, from 269 to 378; in Tynemouth, from 26 to 378; in Newcastle-upon-Tyne, from 374 to 434; in Kendal, from 160 to 213.

Surveys and a Plan of the Metropolis should be prepared.

11. It is clear, therefore, that though we remain inactive, disease and death do not. For the last eight years the startling fact has been proclaimed, and has been constantly urged on the attention of the public and the legislature, that *every day's* delay in the adoption of efficient sanatory measures *costs the lives* of 136 persons in England alone. And yet the tardy Bill which at length comes proposing remedies excludes the metropolis. Why must this waste of life go on unrestrained, without even any attempt to check it in this important portion of the empire? But if this be indeed for the present inevitable, if legislation for these dense and closely packed masses of the people who so grievously need it must be postponed at least for the present session, surely it is practicable at once to prepare the way for legislation, first, by causing an Ordnance Survey to be made of the metropolis similar to that lately made of Windsor; secondly, by causing an advanced report to be prepared as to the proper means of placing and keeping the sewerage, the drainage, the supply of water, and the cleansing of the metropolis in a satisfactory condition, together with plans and estimates showing the probable cost of works, and developing the mode by which the money required may be raised and be repaid: and, thirdly, by causing a similar report to be prepared as to the special means for the accomplishment of these objects applicable to Ireland and Scotland. It is submitted that the result of these inquiries might be embodied in one or in separate Bills to be laid before Parliament at the opening of the ensuing Session.

A distinct Supervising Authority should be created.

12. The Marquess of Normanby, who, when Secretary of State for the Home Department, earnestly took up the subject of sanatory improvement, and was the first to propose in Parliament, and statistically

t eloquently, most eloquently, from the very dryness and nakedness
the calculations, to show the legislature the paramount importance
comprehensive and efficient remedial measures, declares* it to be
s firm conviction, the result of the laborious attention which he had
ven to the subject, that no legislative enactments will, in practice,
found to be effectual, unless a distinct authority be appointed to
perintend and enforce the execution of the law; and he states it to
his opinion, that "some central superintending authority will have
be created, referring, if necessary, to the executive government, but
aving the same sort of powers with reference to local bodies intrusted
ith the execution of the details of these measures that the Poor Law
ommissioners have with the Boards of Guardians." The uniform
pinion of the witnesses examined on this point by Her Majesty's Com-
issioners is the same; and several persons whose opinions are entitled
great consideration affirm it to be their full conviction that the ap-
ointment of such an authority is of so much importance, that without
there is risk of the practical failure of the best devised measure.

Home Secretary too much occupied.

13. Instead of this, however, the Bill proposes to give the superin-
endence of the Act, of all men, to the Secretary of State for the Home
epartment. Now of all the officers under the Crown, or in any depart-
ent of the public service, there is perhaps no man for every moment of
hose time there is so incessant and importunate a demand, and who is
lways so completely overwhelmed with business. That he should be
apable of mastering and directing any new subject requiring serious
nd sustained daily attention is impossible. The imposition of any
uch new task upon him must necessarily be accompanied with the
nquiry—which of his present duties can be otherwise provided for, or
which is it safe to neglect? He is a chief minister of the Crown.
Can he give up his seat in the Cabinet, or cease to share the responsibility of its councils? He is the leader of a political party in Parliament. Can he abridge the time or lessen the attention at present appropriated to the business of the House of Commons? He is the chief magistrate of the nation; the head of the metropolitan and the country police; of the stipendiary and the unstipendiary magistracy. There are at present for the whole of the country 100,000 commitments in the year. In a paper recently read before the Statistical Society by

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* Speech of the Marquess of Normanby, in the House of Lords, on Friday, 26th July, 1844, p. 8.

the Rev. Whitworth Russell, one of the prison inspectors, it is show that although the offences against the public peace are diminishe yet that several large and serious classes of crime are progressive and steadily increasing, and that this is particularly the case wi juvenile delinquency. With a youthful population thus ripening f the prison, the convict-ship, and the scaffold, is the state of crime satisfactory that his attention to this subject can be relaxed? He charged with the regulation and control of prisons. In what propo tion of the prisons are the arrangements so complete that he can ho for an assurance from the prison inspectors that he need give himse no further concern on this matter? He is the protector of the childre and young persons employed in factories, and the duties of the factor inspectors are under his superintendence. Do the manufacturers o do the factory inspectors inform him that the physical, the educational and the moral and social condition of those children and young person is so entirely satisfactory that he may dispense with all thought abou them? He has taken upon himself the supervision of the New Poo Law, and has practically acted for some time past as the ultimate judge of all the doubtful and disputed cases that arise out of it. Does that administration inspire in the public such perfect confidence; is the number of cases of appeal in all the counties so steadily decreasing; and is the condition of the agricultural labourers in particular so good and so improving, as to render it probable that no further communications will be required between him and the Poor Law Commissioners? He is charged with the duty of superintending the affairs of Ireland, and the public know that he does practically give attention to them Are those affairs likely soon to be in so quiet and safe a state as to need no further care on the part of a chief minister of the Crown? He is a judge of appeal in the last resort in all cases in which the mercy of the Crown is sought, and it is his duty to ascertain in every instance whether that mercy ought to be exercised. Is the state of the business in his office such, can that part of it which must always necessarily come under his own personal and special consideration be such, as to allow him to bring to the performance of this solemn duty a mind unembarrassed, calm, capable of patient deliberation, and of arriving, through conflicting evidence, at a conclusion in conformity with truth and justice, and in harmony with legal decisions?

14. The present Home Secretary, Sir James Graham, is a man of

hletic strength and of powerful intellect. , He is sufficiently expe- nced in public affairs to be able readily to reduce the routine busi- ss of his office to order. It is not probable that he will soon have successor who will devote to official details of ordinary and regular siness more constant, laborious, and persevering attention. In instance has any man filled that office during any length of time who s not borne in his person visible marks of overwork, and the powerful ame of the present Secretary of State for the Home Department is eply impressed with them. That he should be capable of exercising e powers of his own mind in the discharge of any serious additional uties is a physical and metaphysical impossibility. He may, indeed, dopt the conclusions of others, but it is not given to mortal man to aster conclusions without examining, comparing, and testing the par- iculars on which they are founded. But this is a laborious process, nd requires time; and time the Home Secretary has not and cannot ave: not even time to examine his informants as to whether they ossess the qualifications requisite for collecting and analyzing facts, nd for deducing sound conclusions from them. That he has not been ortunate in his late counsellors, apparently the first that offered, is proved by the failure of measure after measure which he has proposed, nd especially by the signal failure of the scheme of medical reform, which, after setting the whole medical profession in a ferment, and sowing the seeds of a vigorous and perennial animosity in every section of it, was at last totally abandoned, to the unspeakable relief and satisfaction of all concerned. And the very measure now in question affords additional proof of the same thing. The recent sanatory inquiries have established certain points with a degree of clearness and completeness that may challenge comparison with any example of sound induction from a large collection and close comparison of facts. It is quite impossible that a man of his intellect could have missed those points, placed as they are in broad and bold relief by the whole tenor of the evidence elicited, if he had had leisure to give the least attention to the subject. But certain proposed provisions in the Bill prove indubitably that he has not attended to it, that he has trusted it to other hands, and has been compelled to stamp with the authority of his name the work of some legal draftsman, who has not only not mastered the subject, but who indicates gross ignorance on several ential parts of it.

15. Let us take, then, what the Home Secretary has already been able to achieve as an indication of what he will in future accomplish. Suppose the Bill as it stands to be adopted by the Legislature, and to become the law of the land. Suppose, for example, that two provisions of it come into force. Suppose the two officers to be appointed under it, namely, the Government Inspector and the Officer of Health, to enter on the performance of their duties. Suppose the Inspector, "after due examination and inquiry," report, as he will be bound by the Act to do, on the condition of a certain town or district, "in respect to the state of the drainage thereof, the quantity and quality of the water supplied to the inhabitants, the average amount of mortality among the population, and generally on the sanatory condition of such town or district, and on any other matters or things which may be deemed necessary and proper for the purpose of enabling Her Majesty to judge of the necessity and expediency of ordering the provisions of this Act to be in force within such town or district." Suppose, further, that having prepared his Report and accompanied it with "a plan in which he describes, defines, and marks down the most convenient and proper boundaries of the town or district, having regard to the necessary drainage, level, and other natural features, together with the number of inhabitants," he proceeds "to divide the town or district into wards, and to set out in his plan the extent, limits, and boundary-lines of such wards, and to apportion among the several wards the number of commissioners to be elected by the rate-payers and owners of property." Suppose, moreover, that in conformity with the Act, the Inspector's plan be published "in one or more newspapers circulating within the town or district, and that copies of it be sent to the town-clerk or to the clerk of justices acting in the petty sessions, and to the overseers of parishes, who cause the same to be fixed on the churches and chapels, with a notification, that during the space of one, or as the case may be, two months, any owner or occupier of property within the town or district may forward to the Secretary of State written statements setting forth any grounds of objection to the adoption either as to the whole or any part of the Inspector's plan, and preparing any other plan, substitution, alteration, or amendment." Suppose that the owners and occupiers of property avail themselves of the privilege here offered them, which they are pretty sure to do, and that the Secretary of State is satisfied neither with their representations

nor with the plan of the Inspector, and that therefore "he direct another inquiry to be made either by the Inspector or by some other person thereto specially appointed, as the case may require;" and that after all these investigations the Secretary of State makes up his mind as to what part of the objections of the owners and occupiers is valid, and what parts of the Inspector's plan are good. Suppose the Secretary of State to go through the whole of this process, which he is required by the Act to do, before any Order in Council is made for enforcing the provisions of the Act in any town or district; suppose him to go through this process for all the cities and towns in England and Wales. Suppose at the same time that the medical officers of health, appointed in the several towns and districts, forward their reports as to the sanatory condition of their respective districts; the prevalence of epidemics increasing the rate of mortality; the existence of nuisances acting injuriously on the health of the inhabitants," and that they propose "certain, immediate, and efficacious modes for checking and preventing the spread of disease." Suppose all this to be going on in every part of the country, who, without experience of it, can estimate the amount of attention and labour required to understand and direct such complicated and disputed matters? Is it conceivable that the man who has been prevented by the pressure of the business of his office from mastering the very evidence of the Sanatory Commission on which the Act is founded, collated, and set in order, as it is, for his consideration, so as to enable him to cause the provisions of the Act to be in conformity with the evidence, will be able, when the Act comes into operation, to take the charge for the whole of the kingdom of such details as those which are here enumerated, and which the Act presumes will be under his constant and vigilant superintendence?

Privy Council a better supervising authority than the Home Secretary.

16. If the recommendation of Lord Normanby were adopted, and a special authority were created for the purpose of superintending the execution of the Act, it is clear that there would be work enough here to occupy the sole attention of the most highly skilled and energetic men for a series of years; while the whole tenor of the evidence collected by Her Majesty's Commissioners fully shows that the continued *and* responsible supervision of such men would, by enforcing the *uniform* adoption of the best plans of work, and by preventing *needless expenditure*, save the waste of hundreds of thousands of *pounds annually*. But how is it possible that this can be done by a

single man, whose intellectual and physical powers are already taxe like those of the Secretary of State for the Home Department What, in point of fact, would be the practical result of vesting th superintendence of the means of carrying out the sanatory improvement of the population in the hands of the Home Secretary? Neithe more nor less than to abandon the matter to the chance zeal of some clerk or some other unknown and irresponsible subordinate. If by some remarkable accident this person should come really to understand the subject, and knowing its importance should venture to press attention to it, he would excite displeasure for his importunity and the trouble he gives, and would have his vexation at the neglect and the uselessness of his labour for his reward. Rather than this, and supposing that the recommendation of the best informed and most experienced persons who have paid attention to this subject is not to be followed, it is submitted that it would be an improvement on the plan proposed by the Bill to place the whole of the superintending authority in the Privy Council rather than in the Home Secretary, because the Privy Council might delegate one or more of their body to pay special, constant, and public attention to the matter.

No provision in the Bill to coerce a refractory Commission.

17. Connected with this essential point of making adequate provision for the due execution of the Act, it must be stated that there is a further omission in the Bill, which, in the opinion of your Committee, is also a fundamental one, namely, that no power is taken for coercing a refractory commission. It is indeed provided (clause 96, p. 33) "That the report of every Inspector shall be forwarded to one of Her Majesty's principal Secretaries of State, who shall take the same into his consideration; and if it shall appear to such Secretary of State that the provisions and regulations of this Act have not been complied with, or that any of the said Commissioners have exceeded or contravened the powers and provisions of this Act, then such Secretary of State shall certify the same to the Attorney-General, who shall proceed to enforce the law against such Commissioners." But this provision, as it at present stands, is admitted to be nugatory. It is submitted that any act of wilful and continued disobedience to an Order in Council on the part of any individual or any board of Commissioners, should be made a misdemeanour, and then the Attorney-General would know what to do, and would have power to enforce obedience.

Initiation of plans should not be confined to the Inspector.

18. With respect to the provisions of the Bill for initiating inquiry o the condition of any town or district, it appears to be inexpedient restrict the initiation of plans of improvement to the Inspector. As e Bill is at present shaped, it assumes (page 92) that no plans of im- ovement, or none worth attending to, will be initiated within the wn or district. This may frequently be the case, but it will not invariably so: on the contrary, the examination of plans suggested others, may possibly become a very important part of the Inspec- r's duty. It is submitted, therefore, that the Bill should assume that ans of improvement may be initiated within the locality, and that it ould provide "That the Inspector shall examine any plans and esti- ates of works for the better drainage and supply of water within the undaries of the district in question; and if upon view and survey such district it should appear to him that such plans are imperfect, supply deficiencies, or, if wholly inapplicable, he shall prepare other ans; or if no plans have been prepared, then he shall prepare such w plans and estimates, with a report."

Mode of electing Boards of Commissioners.

19. With regard to the machinery proposed by the Bill for the elec- on of Boards of Commissioners for carrying into effect the provisions the Act, it is submitted that there is no sufficient reason for the de- ation from the scale of property-qualification and mode of electing oor Law Guardians. By the mode of election proposed in the Bill, e electors are taken out of their business to attend the poll clerk the polling-place—an inconvenient and expensive mode of election, hich will practically throw the election into the hands of those whose me is of the least value; whereas by the distribution of voting-papers, d the collection of those papers by responsible officers calling at the uses of the electors, it is found that large numbers are enabled to te who cannot conveniently, and will not willingly, go to distant lling-places. If the mode of election now in use throughout the oor Law Unions were adopted—as it is submitted it might be by mple reference—the length of the Bill would be very materially iminished.

Commissioners should supervise not execute works.

20. There is another subject to which your Committee would beg to irect particular attention. It appears to your Committee that the ill as it at present stands embodies a large practical and fundamental rror which has been fully pointed out and earnestly insisted on by reat numbers of witnesses, namely, the error of making a numerous

local Board mainly an executive instead of a supervising Board. whole tenor of the evidence collected by Her Majesty's Commissi shows that the general inefficiency of the works undertaken b Commissioners of Sewers, as well as the unnecessary expense waste incurred by them,' are attributable to the executive auth given to such bodies, amongst whom responsibility is divided and and that the remedy is to secure the preparation of plans, and to centrate the responsibility of initiation and approval on properly q fied paid officers, as on the proposed Inspector for the larger, an the proposed local Surveyor for the minor works. In accordance this experience and the recommendations of the highest authoritie is submitted that the Bill should distinctly set forth that the Surv should be required to have the qualifications of a civil engineer, that on him should be distinctly charged that responsibility w never has been and never will be borne by a numerous, fluctuat unpaid, and unqualified body of men. It is submitted that it sho be distinctly stated and set forth in the Act, that the Commission are a body for supervision and general direction only, and not for execution of works.

Westminster Court of Sewers.

21. Among the results of the inquiry by Her Majesty's Comm sioners, perhaps at once the most remarkable and the most instructi are the instances which it has brought to light of the waste of public money and the injury of the public health consequent on gran ing to an irresponsible body the power to adopt or reject public wor of the true character of which they are incompetent to form a ju ment, and at the same time in the execution of which they have sinister interest. Your Committee think it important, as an illustr tion of this, to direct attention to two or three facts which are stat in evidence in relation to the administration of the Westminster Cou of Sewers. Mr. Butler Williams,* civil engineer, states, that in th Westminster district upwards of forty miles of covered sewers hav been built within the last ten years; that the whole of these sewer are faulty both in form and construction; that the *difference* of ex pense between the construction of the upright-sided sewers with ma holes (the form adopted in the Westminster district) and the egg-shap or arched sewers with flushing apparatus (the improved form adopted in the Finsbury district) is about 1800*l.* per mile; and that by th

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* First Report, vol. ii. p. 462.

option of the former instead of the latter by the Westminster Comssioners of Sewers, there has been a positive loss of 66,669*l.* 15*s.*; sum," adds this witness, "sufficiently startling to cause the inirer to scrutinize with care the reasons that are advanced in favour the adoption of a form theoretically imperfect, and found practically t to answer so well in some cases as the more perfect theoretical ape which would produce such a great saving."

Evidence of Mr. John Leslie.

22. On the "reasons" that have probably influenced these Comissioners, the evidence of Mr. John Leslie, one of their own body, rows some light. Mr. Leslie, one of the Commissioners of the estminster Court of Sewers, states,* that a large proportion of the ting Commissioners for Sewers in this district are in practice here architects, surveyors, agents, and solicitors, or are otherwise conected with building property; that he regards such appointments as ighly detrimental to the public interests; and he gives a history of e King's College Scholars' Pond Sewer as an illustration of the anner in which the business of this court is conducted. It appears at the then existing line of sewers for this district was in 1807 inutely surveyed by John Rennie, Esq., civil engineer, who reported hat it was not only laid down in so irregular a direction, but so imerfectly executed, in such bad repair, and had so bad an outfall into he Thames, that it would only be wasting money to attempt to render perfect; and Mr. Rennie lays down a plan by which this witness hinks the drainage of this important district would have been comlete. But instead of adopting Mr. Rennie's plan, the Commissioners et to work to repair the old sewer which Mr. Rennie had condemned, hough the report of their own surveyor contains the following emarkable words:—"Begging it may be understood that I am ost perfectly convinced of the superior advantage of Mr. Rennie's lan, I now proceed, in obedience to the directions I have received, to onsider what alterations will be required in the existing sewer."

23. Notwithstanding the condemnation of this sewer by both their rofessional advisers, and after this official condemnation of it, the ommissioners have actually expended upon it nearly two hundred housand pounds! Thus the entire length of the sewer being 16,522 eet, they have spent upon a small portion of it, namely, upon 5233 eet, the sum of 70,104*l.* 17*s.* 6*d.*; and of the portion upon which this mount of money has been expended, it is stated that it is at the pre-

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* Second Report, vol. i. p. 157.

sent moment an open uncovered sewer (with the exception of 1009 fe recently covered in by Mr. Cubitt at his own expense), "with outlet so bad, that the water is penned back during a considerab period (six hours) of each tide; a most disgraceful nuisance in a gre metropolis." On the remaining part of this condemned line the Com missioners have spent the further sum of 100,000*l.* and upwards; an with this result, that the very evils of this sewer which existed prior the expenditure upon it of a single shilling of this money, still exist their full force.

Of this a striking proof has been just afforded in the lamentable de struction of property caused by the recent storm, to the inhabitants Bond Street, Avery Row, Burton Street, &c., in consequence of th erroneous line of this sewer. It was to prevent evils of this very de scription that the inhabitants of this neighbourhood forty years ag caused a survey of this sewer to be made by the ablest engineer then liv ing; and now, after the inflictions of forty years, and the expenditur of 200,000*l.*, the inhabitants, the rate-payers, are just where they wer

In the same spirit the Commissioners purchase for their office a hou the property of a deceased Commissioner, allowing individuals of th body, having a personal or family interest in the sale, to manage affair. They pay for this house 5000*l.* purchase money; and th spend upon it in repairs the further sum of 4903*l.* 3*s.* 1*d.*, though fro the reports of the two surveyors appointed to value the premises it pears that their sworn valuation, 4500*l.*, amounted to very little mor than the sum expended on repairs and alterations alone. "The hous says Mr. Leslie,* "was purchased of the family of a deceased Com missioner for 5000*l.*, it cost to repair and fit it for the purpose of Commission, including 148*l.* 12*s.* 6*d.* interest on the tradesmen's a counts, and also including 219*l.* 1*s.* 10*d.* law charges, 4908*l.* 3*s.* 1*d.* making the total charge to the public for that office within a fractio of 10,000*l.* The tradesmen who were employed, and received amount of nearly one-half of the sum expended in repairs and alterations, appear to have been upon the juries at that period."

24. Further, these Commissioners have recently executed on th Ranelagh line, near the Bayswater-road, what they call a diversion the sewer, 1167 feet 9 inches in length, at an expense of 3471*l.* 10*s.* 0½*d.* a work which in a short time after its completion is discovered to be in so ruinous a state as to require an almost entire reconstructio

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* Second Report, vol. i. p. 168.

Still more recently another failure of a sewer in the same district has been announced, built by the same contractor, and under the same clerk of the works; this new sewer requiring to be reconstructed for the length of 240 feet, at an estimated expense of 360*l.*

25. It appears, moreover, that some of the Commissioners, being contractors for the works, have succeeded in introducing a sliding scale, which continues to the present time, by means of which the lower the price put in the contract as the foundation of the prices therein stated, the larger will be the amount paid to such contractor—a plan which seems to have originated with a commissioner-contractor, and to have been approved by an architect or surveyor-chairman. And with such success do these Commissioners watch over the strict execution of the contracts, that in an instance specified,* while they have been careful to save the public about 30*l.* on the number of bricks, they have at the same time allowed the public to lose about 1000*l.* on the digging. "These," says Mr. Leslie, "are about the sums upon these two items of which I now give many of the details, upon which a loss has been incurred. It may altogether amount to about 1500*l.* It would be a work of very considerable labour to make out all the details; but the above calculations will afford some idea of the pecuniary loss from the carelessness (to say the least of it) with which these tenders and contracts were made."

Evidence of Mr. Butler Williams.

26. Of the magnitude of the sums which may be thus lost some conception may be formed from the evidence of Mr. Butler Williams,† who says: "When we consider the number of miles of covered sewerage in the metropolis, which I suppose cannot be less than about 300 miles, we can form an idea of the saving or waste, as the case may be, which must result from the adoption of one or the other plan. Considering the work done within the last ten years, for which we have exact information, it appears that—

	Miles.
"In the city of London the increase has been above	13
In Westminster	40
In Holborn and Finsbury	21
In Tower Hamlets	13
In Surrey and Kent	11
"Making upwards of . . .	118

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* Second Report, vol. i. p. 179.

† First Report, vol. ii. p. 462.

built in ten years. Now the *difference* in expense, as has been already stated, between the construction of upright-sided sewers with man-holes, and egg-shaped or arched sewers with flushing apparatus, would be about 1800*l.* per mile, or for 118 miles would be nearly a quarter of a million."

27. "Large as this sum is," continues this witness, "it only embraces a comparatively limited view of this great question; and although I should regret that the financial aspect were the only one under which it should be considered, still it cannot fail to be of value to investigate the subject under that view; and if the investigations were carried closely into every particular in which a saving might be effected by the judicious application of science, the sum which I have so far brought out would, I believe, be found to be but a part of the extensive economy that would be the result. The money thus saved might be applied to defray the expense of those sanatory improvements the necessity of which is now so generally acknowledged, but the adoption of which may possibly be delayed in the fear of incurring great expenditure."

Obstructions to Sanatory improvement.

28. But it is proved in evidence that the money thus wasted, instead of promoting sanatory improvements, tends directly to obstruct them, and to add enormously to the rent of the poor man's house. How it operates in producing this result is clearly shown by Mr. Jeremiah Little, a builder chiefly, as has been already stated, of third and fourth-rate houses. According to this witness,* "he is compelled by the Commissioners of Sewers to make sewers of the second-class size for fourth-class houses; a sewer of one half the size would be quite sufficient for the houses he has built; it is the general complaint of the builders of such houses that they are compelled to build sewers of double the size that is necessary; in this manner he is obliged to pay a guinea for work that need cost only 5*s.*; he is compelled to pay for entrances into the sewers 16 guineas, which he could make himself for 4 guineas; these unnecessary charges occasion a great addition to the rent of the house of the labouring man, and to have so much money to pay for the sewers and drains is the reason why builders do all they can to evade them."

29. The unnecessary charges on the fourth-rate tenement, say Her

* First Report, vol. ii. p. 303 et seq.

Majesty's Commissioners to this witness, would then appear to be nearly as follows:—

	£	s.	d.
Sewers, 7*l*. 10*s*. instead of 4*l*., entailing on the *annual rent* an excess of		7	9
Cost of inserting the neck of a private drain into the sewer, 1*l*. 1*s*. instead of 5*s*., an excess of .		1	9
Private drains, 3*l*. instead of 1*l*. 10*s*., an excess of		3	4
Water apparatus, 4*l*. instead of 2*l*., an excess of .		4	5
Water supply, annual, 1*l*. 6*s*. instead of 8*s*. 6*d*., an excess of		17	6
Surveyor's fee, 2*l*. 2*s*. instead of 10*s*. 6*d*., an excess of		3	6
Fire insurance risk, 10*s*. instead of 2*s*. 6*d*., an excess of		7	6
	£2	5	8

Entailing on the builder of your class of labouring men's tenements an immediate outlay of 17*l*. or 18*l*. instead of 8*l*. or 9*l*., and subjecting the labouring men's families who inhabit each house to a perpetual excess of nearly 2*l*. 6*s*. for household purposes, for an administration which produces drains and openings into the houses, and sewers which emit pestilential smells; water, which is sometimes complained of as bad, and scanty in supply for fires: is this so? "Yes; I consider this is our case, which it will be a great saving and blessing if we can have remedied."

Commissioners should be prohibited from executing works without plans and estimates of responsible officer.

30. The facts now stated afford only a very imperfect illustration of the extent to which the comfort and health of the public, and more especially of the poorer classes, are involved in these transactions, and of the magnitude of the sums of the public money that are at stake; but they are sufficient to show that a body so constituted—fluctuating, without professional knowledge, and irresponsible—ought not to be intrusted with such interests; and that this body ought to be prohibited by an express enactment from undertaking any works that are not set forth in original plans and estimates by the proper and responsible officer.

Bill empowers Commissioners to execute works.

31. But the Bill, instead of charging the responsible officer with the duty of preparing in all cases plans and estimates, expressly empowers the Commissioners to commence and execute works. Thus clause 130 contains the following words:—"The said Commissioners

shall have authority, from time to time, as they shall see fit, to wide deepen, embank, alter, arch over, amend, clean, and scour out all an each of the sewers within such town and district." No mention here made of the surveyor; not a word is said about surveys, plans, o estimates; by the terms of the clause, power is expressly given to th Commissioners themselves to act as they shall see fit, without reserv or limitation; and if such terms are retained in the Act, experienc shows that this is the interpretation which will in practice be put upo the clause. The Commissioners will say: "By the express terms o the Act *we* are empowered to widen, deepen, embank, alter, &c., a *we* shall see fit. The words of the Act are, *The said Commissioner shall have authority*, from time to time, as *they* shall see fit. No obligation is imposed upon us even so much as to consult our surveyo much less are we required to work only according to his surve and plans. Authority is given to *us* to execute the works accordin to *our* judgment, and we will use it."

82. And we know from past experience that they will use it; without consulting their responsible adviser, nay, contrary to hi counsel, they will use it. We have seen an instance in which they have thus acted, disregarding the opinion first of the most eminen engineer of the day, an opinion given after a careful survey of th work and district in question; and secondly, disregarding the opinion o their own surveyor, an opinion in perfect accordance with that of th engineer consulted; in defiance of these professional opinions, pursuin their own course, and, after an expenditure of 200,000*l.*, producing a work which is pronounced to be "a most disgraceful nuisance."

83. It has been said "The Commissioners will of course consult their officer; their surveyor will of course inform them." But the standing answer to all expectation of this kind is the conduct of the Westminster Commissioners of Sewers. The course pursued by these Commissioners is only an example of that commonly adopted. It is proved in evidence that parties interested in particular works will get themselves elected, for the purpose of securing the adoption of their own plans, and that they will take care to exclude all advice or influence that can interfere with their object. It is remarkable, indeed, that much of the extravagance, waste, and jobbing which has been brought to light in the course of the inquiry by Her Majesty's Commissioners, has been pointed out confidentially by intelligent paid

fficers, who did not dare to display it publicly, or even so much as to xpress an adverse opinion upon the plans of the Board—not being 'required" or authorized to give any opinion, and being quite sure hat, if they did, they would expose themselves to persecution.

34. The apparently unimportant powers proposed by the Bill to be given to a fluctuating, unprofessional and irresponsible body, to "widen," 'deepen," "arch over," and "embank," as they shall see fit; also to 'scour, cleanse, drain off into any sewers, and otherwise abate all stagnant pools, ditches, and other receptacles of foul water and filth existing within the said town and district," are in reality very extensive, and relate in general to large operations, involving large expenditure. If hese operations are left, as the Bill proposes, to the initiation of the Commissioners; if it is not provided expressly that the professional and responsible officer shall initiate them, grievous waste will continue to be incurred. According to the statement of Mr. Roe,* the engineer of the Holborn and Finsbury Division of the Metropolis, in consequence of the original error as to levels in certain metropolitan districts, it would now require the expenditure of half a million of money to put these levels in a satisfactory state. The area of some of the districts, such as that of Manchester and Salford, which would come within the provisions of the Act, would perhaps be as large, or even larger, than the division of the metropolis named, and possibly the required deepening of the sewers would be as expensive. Supposing the terms proposed in the present draft be adopted, and applied to the metropolitan districts, there is no security that the Commissioners, "acting and altering as they shall see fit," might not set aside the improved and economical plans of the able sewer-engineer whose evidence is cited, and adopt such as those which are in use in the adjoining divisions of the metropolis—the Westminster division for example—and tax the whole of the property there to double or treble the amount for inferior works.

Clause enacting that the Surveyor shall prepare plans and estimates.

35. Instead therefore of the terms proposed in the Bill, the following amendment is submitted, as conformable to the experience of practical men and the recommendation of Her Majesty's Commissioners: "And be it further enacted, That the Surveyor of the Commission shall prepare plans and estimates for all alterations of the sewers, by deepening, widening, embanking, arching over, or otherwise altering the

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* First Report, vol. ii. p. 173.

same, and shall inform thereof the owners and occupiers of the lands and houses drained by such sewers; and if the Commissioners shall approve of such alterations, they shall direct public notice thereof to be given as hereinafter provided, and shall hear objections thereon, and shall, as they shall see fit, direct amended plans and estimates to be prepared, and shall have authority to direct notice or public advertisements to be made for tenders to execute such works upon contract," &c.

Plans and estimates of Surveyor to be submitted in every instance to Inspector.

36. By clause 68 it is provided that "before any such works shall be begun, or any contract finally made for executing the same, the plan of such works, together with the estimates of the expense of completing the same, shall be submitted by the Commissioners to the Inspector, and shall have been approved by him." It is submitted that this provision ought to be made universal by an express enactment rendering any deviation from it in any case or under any pretence whatever unlawful; requiring first, that the Commissioners in every case shall cause plans and estimates to be made by their Surveyor; *secondly*, that they shall examine these plans and estimates as to their expediency, efficiency, and completeness; thirdly, that they shall submit these plans and estimates, when approved by them, to the Inspector of the district for his examination; and, fourthly, rendering the sanction of this superior and responsible officer absolutely necessary to the commencement of any works whatever. In the opinion of your committee, nothing short of this will secure to the service of the public uniform economy and skill, or will prevent needless and grievous loss from ignorance, negligence, and jobbing.

All works should be executed by contract.

37. The evidence further shows that the Commissioners ought not to be allowed to execute the works themselves, nor even to execute them by their own officers, but that they ought to be *required by an express enactment to do every thing whatever by contract, their Surveyor being made responsible for the proper performance of the Contractor's work.* The exceptions to the rule, that all work should be done by contract, should be limited to cases of sudden and pressing emergency, and might at all times be determined by the Inspector. So satisfied are Her Majesty's Commissioners of the soundness of this principle, and of the importance of acting upon it, that they report as follows:—

"[*] In addition to the securities for efficiency and economy, on which we have already given our opinions, namely, the determination by surveys of areas for efficient works of drainage; the examination or preparation of plans of new works by competent engineers, before any new works are undertaken; the execution and maintenance of them by properly qualified officers—we have to recommend as another and important security, a provision requiring that all such works should be executed by contract upon open tenders."

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[*] Second Report, vol. i. pp. 103, 104.

38. The Bill, as at present drafted, however, is not in conformity with this recommendation. It does not make the execution of works by contract absolutely and peremptorily binding upon the Commissioners; but merely gives them a permissive authority to enter into contracts. The words of clause 68 are

Defective provisions of the Bill.

"And be it enacted, *That it shall be lawful* for the said Commissioners to enter into contracts with any person or persons for the execution of any works directed or authorized by this Act to be done by the said Commissioners, or for furnishing materials, or for any other matters or things whatsoever, necessary for the purposes of this *Act*: and every such contract shall be in writing, and shall specify the several works to be done, and the materials to be furnished, and the prices to be paid for the same, and the time or times within which the said works are to be completed, and the penalties to be suffered in case of non-performance thereof, and shall be under the common seal of the said Commissioners, and shall also be duly executed by the person or persons contracting to perform such work or works respectively; and such contract shall be binding on the said Commissioners, and actions and suits may be maintained thereon, and damages and costs recovered by or against the said Commissioners, or the other parties failing in the execution thereof; and a copy of every such contract shall be entered in a book to be kept by the Clerk to the Commissioners for that purpose."

It is submitted that instead of the words "*That it shall be lawful,*" the following words should be substituted:—THAT ALL WORKS WHATSOEVER, *directed or authorized by this Act,* SHALL BE EXECUTED ONLY BY CONTRACTS UPON OPEN TENDER, and every such contract shall be in writing, &c.

39. Her Majesty's Commissioners add:*—"An additional security will be given if such works be maintained and kept in good repair for terms of years on contract by the parties by whom they have been executed, whose interest would thus lead them to make good and sufficient

Contracts should be made for terms of years.

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* Second Report, vol. i. p. 104.

works in the first instance [illegible]. If the contractors have a fair liberty, as to the means, and a share of the first benefits of new improvements, such improvements will be soon made and rapidly carried into execution to the public advantage."

40. It appears to your Committee that these observations, being as they are the result of large experience, ought to guide legislation on this matter. All the authorities concur in opinion that a provision binding the contractor to the maintenance of the works for terms of years, is a security for original good construction, and that this is a condition which ought invariably to be insisted on in every contract.

At Manchester it is provided that the contractors for the construction of sewers shall maintain them in good condition for three years. In other places similar contracts are entered into. The construction of roads has been contracted for on the condition of keeping them in good repair for three years; and there is no reasonable doubt that the period for keeping the works in repair may be extended for any number of years. Mr. Roe, the greatest practical authority on that subject, says,[*] "The extension of the period of the contract for maintaining such works in good condition would be beneficial to the contractor. If I were a contractor, I should like to contract for keeping them in order for twenty or thirty years, for I know that if sewers are originally well constructed, they will last for centuries without any thing being done to them."

Contracts for extraordinary works.

41. Moreover, it would be a practicable and important provision that in all contracts for the maintenance of sewers the contractor should be bound to undertake any extraordinary works on a fixed remuneration of per cent. on such outlay as may be just and reasonable, to be approved by the Inspector.

Facilities for forming contracts with public companies.

42. Her Majesty's Commissioners further state,[†] "Many of the works are, however, too large for single contractors; and it appears desirable to give facilities for the execution and maintenance of such works by public companies, as lessees or contractors for terms of years, with liberty of redemption by the public upon terms previously settled. We are informed that such works would frequently be executed and maintained, and all risks undertaken, upon such terms as a *guaranteed* profit of six per cent. on the outlay. When money has been borrowed, the usual market rate of interest for such investments has hitherto been four and

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[*] First Report, vol. ii. p. 154 et seq.

[†] Second Report, vol. i. p. 104.

half or five per cent. An addition of one-and-a-half per cent., for hich a company would often undertake the maintenance and execution such work, would be cheap, as compared with the risks of mismanageent by local boards, composed of persons having no professional skill, nd liable to be misled as to the materials and magnitude of the proposed orks, as well as to the number of officers requisite to maintain them. t might be difficult to ensure that a local body should be so constituted s to give the same constant attention to economy in the expenditure f other people's money that contractors would do in the expenditure nd management of their own."

No such facilities given by the Bill.

43. Your Committee fully concur in the practical importance of his recommendation, and regard it as a material defect of the Bill hat no provisions are framed in accordance with it; that no facilities re afforded for the formation, and no guarantee given for the protection, of Joint Stock companies to carry out by contract works which require great capital, and which are too large for single contractors. Such companies are capable of raising the capital required for the xecution of public works on a scale sufficiently large to combine the everal objects which it is necessary both for economy and efficiency to carry out simultaneously, with one design, on one plan, and under one direction; and at the same time they afford the best security that the money, when raised, will be honestly and wisely expended. Your Committee entirely concur in the opinion of Her Majesty's Commissioners just quoted, that "it is difficult to ensure that a local body shall be so constituted as to give the same constant attention to economy in the expenditure of other people's money that contractors would do in the expenditure and management of their own." The object of the legislature should be to ENGAGE AND REGULATE THE SPIRIT OF COMMERCIAL ENTERPRISE IN THE EXECUTION OF THE MEASURES OF SANATORY IMPROVEMENT. With this view it should remove the existing impediments to the formation of public companies for the purpose of carrying out the large operations required by those measures, endeavouring to find some mean between the dangerous latitude at present afforded to local, fluctuating, unskilled, and irresponsible bodies, and the no less dangerous latitude that may be given to Trading Companies, invested with powers without adequate supervision and control.

Means of raising the neces-

44. Sanatory improvement, to be effectual, must be carried out on a vast scale. There is scarcely a city or town in the kingdom

sary capital for large Sanatory Improvements.

which does not need extensive works to place either its drainage, i sewerage, or its supply of water in a satisfactory condition, an in the great majority it is necessary that such works should be commenced almost entirely anew. But the difficulty of enforcing by legislation the general adoption and completion of works of such magnitude, is the expense which they must necessarily involve. Had the recent inquiries done nothing to show how this expenditure can be met, but little progress would have been made towards the practical introduction of remedial measures. These inquiries, however, do point out in the clearest manner, first, how the required capital can be raised; secondly, how it can be repaid; and thirdly, how the repayment can be so distributed as not to be felt as a burthen by the persons who ought in justice to defray the expense. These three things having been shown, all real difficulty on the part of the legislature in enforcing the universal adoption of primary essential sanatory improvements, may be said to be at an end.

By Loans, the repayment to be spread over a series of years, and to be secured by a special rate.

45. The plan proposed is, that whatever capital is required should be raised by a loan, or by persons contracting for the execution of the work, on the security of a special rate, to be levied on the property in the several localities, the principal and interest to be repaid by annual instalments, within a limited number of years. On this plan no immediate outlay is necessary; the burthen is distributed over a series of years, and, being commuted into an annual rent-charge, is not practically felt even by the poorest tenant.

This plan recommended by Her Majesty's Commissioners.

46. Her Majesty's Commissioners, fully appreciating the importance and the efficiency of this principle, say in their first Report:*—"The evidence recited generally recognises that principle of legislation to be just and acceptable which has been suggested for lightening the burthens of future improvements by spreading the expense of the outlay over an extended period, so that the cost might be repaid within a reasonable time, with interest, by an annual rate, or by an addition to the rent, unless when the persons interested choose to perform the work themselves under proper regulations, or where they prefer liquidating the charge at once."

47. The tenth recommendation of Her Majesty's Commissioners contained in their second Report,† is in the following words:—"We therefore recommend that the expense remain a charge upon the pro-

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* First Report, vol. i. p. 23.

† Second Report, vol. i. p. 61.

rties, to be levied by a special rate upon the occupiers, and recovered ith interest by annual instalments within a certain number of years, ıless the owners prefer to pay the cost in the first instance.

Mode of procedure recommended.

48. A mode of procedure in accordance with this recommendation pointed out in a suggested form of notification,* and evidence is ldduced to show, from the testimony of men of the highest authority, iat the adoption of this principle would at once remove all material ifficulty, and give general satisfaction. Thus it is stated by one of Ier Majesty's Commissioners, Dr. Playfair, that "the distribution of harges for improvement, under a competent authority, a system unaniıously recognised by eminent practical men, such as those whose vidence I have already brought forward, would obviate all those vils. The charges should be distributed over a term of years coqual with the probable duration of the improvement."

49. In like manner another of Her Majesty's Commissioners, Mr. mith, of Deanston, states in his Report,† that the adoption of the priniple of dividing the charge over a series of years, and raising the noney immediately required by loan on security of the rates, will reatly diminish [he might have said, may be made entirely to renove] the immediate pressure, and so far remove the hostility of the ate-payers to necessary and efficient works of improvement. Besides, ubstantial justice will be done to life-renters, many of whom have no other source of living but by a limited amount of rent drawn from house property. Nevertheless, I believe that this jealousy might be abated by a properly adjusted and revised system of contract management, which would be cheaper than any other."

50. Mr. Roe says‡:—"On the principle proposed, of the distribution of the charge as a rent over a period coincident with the benefit, nearly the whole inconvenience and all injustice to owners of short interests in the immediate outlay is got rid of; this principle of the distribution of the charge is essential to all plans; it is only justice; the improvement is permanent, and it is manifestly unjust that the whole cost of it should fall on the present owner."

Cost ought to be charged on occupier, not owner.

51. The evidence shows with equal clearness that the cost ought to be charged on the occupier, not the owner. The owner is often merely a lessee having only a short term of his lease unexpired; no cottage

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* First Report, vol. ii. pp. 295, 296. † Second Report, vol. ii. p. 164.

‡ First Report, vol. ii. p. 169.

owner has funds at his disposal for any costly improvement; he has very rarely the fee-simple, or even an unencumbered life-interest in the property; the ownership is frequently so complex, that there is the utmost difficulty in discovering it; a man, for example, gives his property to his married daughters to be equally divided amongst their children; in a case like this, the respective shares in such property could only be ascertained, perhaps, after an expensive chancery suit, while to charge the lessee, or the person in receipt of the rents, who may be within two or three years of the expiration of his lease, with the cost of improvement not unfrequently amounting to more than the annual rental, would be to confiscate his property. The true remedy for all these evils is not only to distribute the cost over a period commensurate with the benefit, but to fix the charge on the person enjoying the benefit, that is, on the occupier, not the owner. "The only exception," says Dr. Playfair,* "is the case of monthly or weekly occupiers, when, to prevent the expense of frequent collections, such charge might be made on the owner, who is now to be looked upon in the light of a collector of rents, and, if need be, to receive a per centage for the additional trouble."

52. How very slight the burthen would be by such a distribution and adjustment of the expense, is proved by the plans and estimates given in a Report published by "The Water Supply, Drainage, and Towns Improvement Company," an association including some of the largest capitalists in Europe. In this Report it is shown that the expense of complete house-drainage, and cleansing, including the substitution of the water-closet or soil-pan apparatus for the privy and the cesspool, may be brought down to a rent of a penny a week for the lowest class of tenements; that constant unlimited supplies of filtered water may be carried into the lowest class of tenements for another penny a week, and that taking one house with another, complete street cleansing may be effected for twopence a week, provided the capitalists who are ready to advance the money and to undertake the risk and management of the works, as contractors, be guaranteed payment by general payments from rates.

Bill adopts old Precedents instead of the recommenda-

53. The Bill, however, as at present drafted, misses these essential points; and instead of adopting the principle laid down in the evidence, and expressly recommended by Her Majesty's Commissioners, takes as

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* Second Report, vol. i. p. 419.

guide the old Local Improvement Acts, just as if no new information d been presented for the guidance of the legislature. Thus the 9th clause is as follows:—

tions of Her Majesty's Commissioners.

"And whereas numerous houses and buildings have from time to me been erected and built, without having proper drains communi- ting therefrom with any sewer, which proceedings are highly pre- dicial to the public good; BE it Enacted, That in all cases where y house or building, situate within any town or district, shall at any me be found not to be drained by a sufficient drain or pipe commu- eating with some sewer, and emptying itself into the same, to the tisfaction of the said Commissioners, and if a sewer of sufficient ze, under the jurisdiction of the said Commissioners, shall pass along y street, and within *Thirty* Feet of any part of such house or build- g on a lower level than such house or building, it shall be lawful for e said Commissioners, by notice in writing, *to require the owner of ch house or building forthwith*, or within such reasonable time as all be appointed by the said Commissioners, to construct and make om such house or building, into the nearest common sewer, a covered ain or pipe of such materials, of such size, at such level, and with ch fall, as shall be adequate for the drainage of such house or build- g, and also, if practicable, of its areas, water-closets, privies and fices, if any, and to carry and convey the soil, drain and wash there- rom into the said sewer; and if the owner of such house or building hall refuse or neglect, during *Twenty-eight* days next after the said otice shall have been delivered to such owner, or left at such house r building, to begin to construct such drain, or shall thereafter fail to arry it on, and complete it with all reasonable despatch, it shall be awful for the said Commissioners, and they are hereby required, to ause the same to be constructed and made, and to recover the ex- enses to be incurred thereby in the manner hereinafter provided."

54. The whole tenor of the evidence shows that these provisions re at once practically inconvenient and altogether vicious in principle. They are practically inconvenient, because, in the first place, it would be difficult, and sometimes impossible, to find the owners, and to serve them with notice; and, in the second place, because the owners, when found, would hardly know what to do, or for whom to send; and the bricklayer and plumber, when at last their presence on the spot is brought about, would do the work each in his own way, without

Provisions of the Bill inconvenient and vicious.

reference to any general plan or system, while their employer would be put to the expense of retail charges, the extent of which he would be wholly unable to foresee.

They are equally vicious in principle, for they assume that the expense of all sanatory improvements must be ultimately borne by the owner. Accordingly, Clause 156 expressly empowers the Commissioners to require the repayment of "all such cost, charges, expenses, and moneys from the owner." Clause 157 empowers the Commissioners to require the repayment "of all or any part of such cost, charges, and expenses, from the occupier, to the full amount of the rent due from him at the time of the demand;" and clause 159 empowers the occupier to deduct from his rent the amount so paid by him under certain specified conditions. Thus, the cost of paving, draining, and providing a house with a privy and cesspool* is, suppose, *5l.* The occupier is required by the provisions of the Bill to pay this *5l.* on demand, if he happen to owe that amount of rent; and should he be a yearly tenant, he may deduct from his rent all but the one-twentieth part of the charge. In this case the owner, instead of *5l.* rent, will receive only *5s.*; that is, the bulk of his rent will be confiscated, for a benefit enjoyed not by him, but by the occupier.

The practical result of these provisions must necessarily be the infliction of injustice and oppression, often amounting to the total confiscation of the rent. The experience of the like provisions under the Building Act shows that such cases will actually occur to a very serious extent. It is true that it is provided by a subsequent clause, that "in case any drain or other work shall have been constructed, made, or repaired by the said Commissioners, the costs of which are to be repaid to the said Commissioners by the owners thereof, it shall be lawful for the said Commissioners, and they are hereby required, in all such cases where the owner shall be only tenant for life [why in such cases only?] of such premises, or where the amount of the sum to be repaid to the Commissioners shall be more than half the amount of the net annual value of such premises, and in any other cases of which the said Inspector shall approve, to allow time for the repayment of such costs, charges, and expenses, and to receive the same by such instalments as the said Commissioners, under the circumstances of the se, shall consider equitable and just, but so that the same shall be paid by annual instalments of not less than one-twentieth part of the hole sum originally due, with interest for the principal money from ne to time remaining unpaid, after the rate of 5*l*. per centum per nnum during the period of forbearance."

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* The kind of benefit to be expected from providing a house with a privy and cesspool is fully shown, p. 63 et seq.

Here, in addition to the trouble thrown on the occupier, still more ouble is thrown on the owner, to whom, when mulcted of more than lf his rent, the consolation is afforded of an appeal to the discretionary mmiseration of the local Commissioners, a body composed largely of embers of the Town Council, and therefore very likely to be party ponents: an appeal to what the Bill terms their "forbearance."

All this is as vicious in principle as it would be vexatious in practice. is directly opposed to the whole tenor of the evidence, and to the press recommendation of Her Majesty's Commissioners.

Difficulties on the principle proposed by the Bill.

55. There are then two courses proposed, founded on opposite inciples. By the Bill it is proposed that improvements shall be paid r at once, and that the cost shall be defrayed by the owner. On this inciple the main difficulty of carrying out sanatory improvements, mely, the difficulty of meeting the immediate outlay, is retained in full force; while the interests of the landlord being always matelly injured, and in some cases his property being confiscated, a commation of this whole class against the bill, and, if it should pass into act, against the due execution of the law, is certain.

Removal of these difficulties on the principle recommended by Her Majesty's Commissioners.

On the other hand, the principle developed in the Sanatory eport, instanced by strong concurrent testimony, and recommended r Her Majesty's Commissioners, is that the expenditure be conrted into a rent-charge, and that repayment both of the prinpal and interest be spread over a term of years co-extensive with the obable duration of the works. On this principle no immediate outlay needed; no application to owners is required; they are left unolested; the money is raised either by loan or by contractors, the ork is done by contractors, and they are repaid for their outlay and bour by equal annual instalments of principal and interest on the curity of a rate. Thus, in the case just put, the cost of paving, aining, and cleaning a house is, suppose 5*l*.: no one, on the prinple here contended for, is called upon for the immediate payment of his 5*l*. The contractor not only raises the money, but agrees to keep ll the work in repair, say for twenty years. The tenement, meantime, may let to twenty yearly occupants, who having each enjoyed one-twe tieth part of the advantage of the improvements, may be justly calle upon to pay one-twentieth part of the total expense: that is to say, 5 All, therefore, that is to be provided for is the annual payment of th instalment of *5s.* by the parties always benefited, namely, the perso always in occupation of the premises. The landlord, meantime, knowin exactly the cost of the redemption of the charge, pays, suppose, the su at once; and in order to reimburse himself, adds one penny weekly t the rent, to be paid by his tenant. In this way the burthen presses on a one; the property of the owner is not confiscated; the charge upon th occupier is not felt; the opposition to improvement is removed; th concurrence of all parties in advancing improvement is gained; th means of meeting the expenditure required are always at hand, an the working of the whole sanatory measure becomes easy and sur But on the opposite principle, that on which these provisions of th Bill are founded, insuperable obstacles are placed in the way of al extended and systematic improvement, and if these provisions ar retained, they will render any sanatory measure, however in othe respects well devised, a certain failure.

Supply of water.

56. Another instance in which the provisions of the Bill are in dire opposition to the recommendations of Her Majesty's Commissioner relates to the measures proposed for securing a due supply of wate As one of the professed and prominent objects of the Bill is to reme the present "extremely defective supply of water for the domestic us of the inhabitants of towns and populous districts, and for the du cleansing of drains," and as an ample supply of water is indispensabl to every sanatory improvement, without which the very means intende as remedies become new sources of disease, it is necessary to examin in detail the provisions of the Bill with relation to this very importan part of the subject.

Intermittent supply.

57. The results of inquiries stated in the Sanatory Report had placed in a striking point of view the superiority of a constant over an intermittent supply of water. Her Majesty's Commissioners have re-entered into this investigation at great length, and have collected a body of evidence on the subject which shows by every variety of proof of which the question admits, that an intermittent supply vitiates the water; is inadequate, and puts the consumer to unnecessary trouble, inconvenience, and expense; whereas a constant supply is practicable.

llone capable of satisfying the wants of the people, and especially :he poorer classes, and is cheaper than any other mode of supply.
[he following may be taken as examples of the kind of evidence m which these conclusions are derived.

Vitiates the water.

i8. First; the common mode of intermittent supply vitiates water nparatively pure at its source, and often deteriorates it to such a ;ree as to render it wholly unfit for use.

[his mode of supply occasions the necessity of butts or tanks—the mon receptacles for water. "The butts," says Mr. Toynbee,* re made of wood from which often the paint has been decayed; netimes the wood itself is decayed; they have commonly no cover the top, and a film of blacks and dust forms on the surface of the water. e water is generally laid on in the yard or lowest part of the pre-es, and a supply is generally given three times a-week, and at each ie the water comes on the film of dust and blacks that has been de-ited on the surface is mixed up with the previous accumulations. en in a more open and less sooty and dirty neighbourhood, as on the face of the Water Company's reservoir in the Green Park, the de-it of soot, or dirt, or dust, may be at times observed as a dark scum carpet spread over it. One patient complained very much of the ality of the water taken from an old wooden butt. In respect to it earned that this same water is used for making bread by a baker o supplies a great number of the poor. Since attention was directed the subject by the Sanatory Report, I have availed myself of oppor-nities of making observations upon it, and the result is, the strong nviction that the quality of the supplies of water and the mode in ich it is received and kept in such atmospheres, influence the diet i health of the population to a much more serious extent than has herto been imagined."

Dr. Aldis states that† in the places he is called upon most frequently visit, the water retained in the rooms of the poor for domestic use oon becomes covered with black scum," and that there is generally ı filthy accumulation on the surface of the water-butts." How can be otherwise, when the water is kept in rooms "small, dark, and ty," which the inhabitants themselves describe as "stinking alive," er-crowded with the living and still occupied by the dead; or when e water-butts are placed in "little back yards without cesspools or privies, where all the excrements are allowed to accumulate for month together, or without drains to the cesspools where the latter exist, s that the excrements run into courts or streets, where they remain unti a shower of rain washes them into the gutter."

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* First Report, vol. i. p. 82.

† First Report, vol. i. p. 113.

"I frequently found," says Mr. Toynbee,* "that the water brough and kept standing in these crowded and close rooms retained dust an other impurities: it no doubt absorbs some of the noxious gas, for i differs considerably from the state in which it is when first obtained The taste of water obtained from the common companies' supplies I have found to be very different from that in which it was first obtained —very peculiar and very unpleasant."

Mr. Quick,† engineer of the Southwark Water Company, states, "We frequently found the butt uncovered, and the water exposed and covered with soot and dust. I frequently find a green scum upon them, which I have imagined arises from some decomposition in the wood. The butts themselves are not well prepared in the poorer districts; old tallow casks, old rum puncheons, anything in the shape of a tub is in fact used, and commonly with little or no preparation, and the matter with which the wood has been saturated will taint the water for a long time. A butt ought to be dressed over with common pitch each year to preserve it properly, but this is rarely done."

According to Mr. Wicksteed,‡ engineer of the East London Waterworks Company, and of the Kent and Vauxhall Waterworks Companies, the cisterns ought to be cleansed once a fortnight, and the butts once a week, and "if people take ordinary care with these cleansings, they will have clear water; but it must depend upon the inhabitants themselves." Experience, however, shows that not one person out of a thousand will take this "ordinary care," the necessity of which occurs as constantly as the day, and that if the supply of clear water is made to depend upon "the inhabitants themselves," they will not have clear water. Mr. Quick § observes that medical men are of opinion that water absorbs the gases by which it is surrounded, and adds, "I have little doubt that it must be so. We know that when water is placed in a newly-painted room, it removes much of the unpleasant effluvia."

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* First Report, vol. i. p. 83.

† First Report, vol. ii. p. 128.

‡ First Report, vol. ii. pp. 24, 25.

§ First Report, vol. ii. p. 128.

Mr. Hawksley,* engineer, states that "the impregnation of water th gas is no uncommon event. The gas-pipes leak, the water-pipes ık; a partial vacuum is created in the water-pipe by the withdrawal of e water, and the gas is drawn in through the aperture. Many instances this kind have occurred; the water taps sometimes take fire, and reral serious explosions in dwelling-houses have been traced to this use."

Mr. W. C. Mylne, engineer of the New River Water-works, states† at very serious inconvenience is sustained by the gas getting into e water-pipes, and that this very frequently happens, especially iere there are competing companies. "I believe,"‡ continues this tness, "the joints of the gas-pipes are very badly made. The whole the earth of some of the streets in which the pipes are laid is so arged with gases, that within the boxes of the fire-plugs, if they are vered over in the evening, the vapour collected in the twelve hours ill ignite in the morning. Our services have been so frequently und charged that complaints are continually being made of gas being rried by them into the houses together with the water. In several stances explosions have taken place, to the injury of the persons rrying down a light. Instances have occurred where, lights being plied to our water-pipes, the gas has ignited, as if the pipe were a s-pipe. I have no doubt that houses are fired by these escapes. A ort time since a sewer exploded, from the accumulated gas having een accidentally ignited, in Rosamond-street, Clerkenwell. It may e smelt issuing from the ground."

Mr. Liddle,§ as an illustration of the state of the water commonly ed for domestic purposes by the poor, observes, that "the smell of ieir linen when they give me a towel, which they tell me is quite lean, is often offensive;" and every one accustomed to visit the houses f the poor must have been struck with the disgusting odour arising om the clothes recently washed and hung up to dry in their rooms, nd regarded by them as clean.

"I have observed," says Mr. Toynbee,|| "the same water, which is ery filthy from having been used in washing some clothes, used again o wash others. The towel given me to wipe my hands with, although

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[*] First Report, vol. ii. p. 51.

[†] First Report, vol. ii. pp. 107, 108.

[‡] Ibid.

[§] First Report, vol. i. p. 106.

[||] First Report, vol. i. pp. 82, 83.

ostensibly clean, yet having been washed in dirty water, was unfit for use."

Intermittent supply inconvenient.

59. Secondly. The intermittent system of supply puts the consumer to great and constant inconvenience in obtaining water, which is felt peculiarly by the poorer classes.

"The system of supplying water usually adopted by companies," report Her Majesty's Commissioners,* "is to turn it on to the several districts of the town at certain periods of the day, generally two or three hours three times a week. The houses of the wealthier portions of the community are furnished with cisterns to receive and retain the water until the period of supply recurs; but among the poorer classes the expense of erecting a cistern, forming a serious addition to the cost of a small house, is dispensed with, and they are obliged to retain the water in such vessels as they happen to possess. It is obvious that they must watch their opportunity of collecting water during the period that it is turned on, and those who are engaged in occupations from home necessarily lose their chance of getting a supply. This inconvenience is particularly felt in districts where women and children have much employment. When pipes are not laid on to each house, much labour is expended in fetching the water, and time is lost in waiting for their turns to fill their vessels."

"In Liverpool," says Dr. Playfair,† "the water is laid on only on alternate days, or (as Sunday is excepted) three times in the week. The hours of service vary from one to two and a half, during which time all the water necessary for two days' consumption must be collected; and if by any chance or necessity the tenant be absent from home during these hours, and his previous supply be exhausted, he is deprived of water for four days. This mode of supply is stated by cottage tenants to be a great inconvenience, especially by those who are unable to afford cisterns capable of containing a supply sufficient for more than two days; and this class of tenants perhaps forms the majority. In such cases they are obliged to collect the water in whatever vessels they can most conveniently procure; and even when this is effected, its retention in the sitting room, where it becomes heated, and absorbs vitiated air, renders it unpleasant as a beverage, and induces the tenant to resort to other injurious modes of allaying thirst. The collection of a proper quantity is no easy task, when it is considered that, by the experience of ottingham and Preston, the average consumption of water for a cottage ould be forty or forty-five gallons per diem; although, according to e evidence of well informed witnesses, the cottage consumption, in verpool, even in the case of a family of more than ordinary cleanliss, rarely amounts to twenty gallons daily."

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* Second Report, vol. i. pp. 90, 91.

† Second Report, vol. i. p. 400.

"It frequently happens," says Mr. Quick,[*] "that the man and oman are out at work during the time the supply is on the common p. When they return home there is no supply; and this may occur om day to day. If the man has work he is generally out, and a rge portion of the women work from home."

60. Thirdly. This mode of supply unnecessarily taxes the strength of ople already exhausted with their day's work; too tired to engage in e new labour of fetching water.

Intermittent supply laborious.

"It is a general and notorious fact," says Mr. Hawksley,[†] "at least is perfectly well known to those acquainted with the feelings and bits of labourers, that they regard it as an intolerable nuisance on eir return home, tired with their day's labour, to have to fetch ater from a distance out of doors, in cold or in wet, in frost or in ow."

"I am compelled to visit their houses at all times," says Mr. iddle;[‡] "it is common to me to see the husband, who has just remed home, lying on the bed fast asleep, with his clothes on; they nnot be expected to fetch water after the labour of the day; it is ly done for the most urgent purposes."

So far are the labouring classes from being able to fetch water after eir return home from their work, that Mr. Toynbee states that he has und one considerable obstruction to their cleanliness to be, their ability to carry dirty water down stairs. "One source of dampness d smell," he says,[§] "I have frequently found, is the vessels of dirty ater retained in the room. The common excuse for this retention is, We are so knocked up with the day's work, that the water must wait ntil to-morrow, when we shall be able to remove it.' The labour of rrying water up stairs is felt as a grievous evil. To mothers espeially, who are often debilitated, the carrying water up stairs is a very reat exertion; mothers not daring to leave a child in the room, have carry the child in one arm, and the vessel of water with the other.

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[*] First Report, vol. ii. p. 124.

[†] First Report, vol. ii. p. 36.

[‡] First Report, vol. i. p. 106.

[§] First Report, vol. i. p. 82.

I have had even sick children neglected and left dirty, and the excuse given has been the inability to fetch the water. Recently I have had a case of this kind. I have attended three children; two of them with scrofulous inflammation of the eyes, the other of them with a scrofulous affection of the throat; all of them rarely washed, and in an extremely filthy condition. The mother is a poor woman, who has been in a respectable condition; but she is now so far advanced in pregnancy as to be incapacitated from going up and down stairs to fetch water. She continually deplores her condition of having neither the strength to fetch a sufficient supply of water, nor the means of paying for it being brought to her."

Intermittent supply inadequate.

61. Fourthly. This mode of supply is so inadequate to the wants of the people, that it necessarily produces habits of negligence both in their persons and houses, and renders the maintenance of cleanliness impracticable.

"In some cases of accident," says Mr. Toynbee,* "such as of sprained ankles or bad ulcers on the legs, which confine the patient to the bed, there has frequently been no water whatever in the room; and, after dressing and bandaging the patient, I have been obliged to try and get water in the next rooms: sometimes there has been none in the next rooms; at other times that which the other occupants have had has been so dirty as to be unfit for use; sometimes I have waited whilst water has been sent for, for me especially; and sometimes I have been obliged to go away with my hands unwashed, and to take the chance of my finding water at a neighbouring patient's. I have observed that the people use a very small quantity of water in cooking; that to save water they put greens into the water without washing them, and to save having to fetch more water."

"Cleanliness," says Mr. Liddle,† "is entirely neglected; their persons and clothes remain in a most dirty state; their clothes are passed through dirty water to avoid the trouble of going out to fetch water."

"The inconvenience of collecting water in vessels wanted for other purposes," says Dr. Playfair,‡ "affords so many inducements for its sparing use, that a proper degree of cleanliness in the habits of the people is prevented." "There ought," he continues,§ "to be no limit part to the supply of water for domestic purposes; but, on the contrary, every facility should be afforded for its unsparing use. I have spent many days in visiting the houses of artisans in towns both well and ill supplied with water; and I can state, as an invariable rule, that there is a marked difference both in the moral tone and the physical condition of the inhabitants of those towns; and this difference is even perceptible, though in a less degree, in the houses of the same town, according as they are or are not freely supplied with water. In Bristol, where there is no water company, and no supply, except from pumps and wells, the dwellings of the lower classes are generally abominably filthy, full of vermin, and in a condition such as I have not seen in any of the large towns of Lancashire."

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* First Report, vol. i. p. 83.

† First Report, vol. i. p. 103.

‡ Second Report, vol. i. p. 409.

§ Second Report, vol. i. p. 401.

"The general and great deficiency in the supplies of water," report Her Majesty's Commissioners,* "and the consequent state of filth which the abodes of the poorer classes constantly exhibit, has, we fear, produced a very general impression that they are not capable of appreciating the advantages and comfort either of personal or domestic cleanliness. The information derived from the investigations of the Commissioners, and the evidence obtained through other channels, has convinced us that this is a most erroneous view of the feelings and wants of those persons, and we are most desirous to correct this impression, which, if it were well founded, would form a barrier to any prospect of improvement, and would render nugatory the recommendations that we may subsequently make for facilitating increased supplies of water. The general habits of the poor, with regard to cleanliness, must not be compared with a high standard; their daily occupations, and the nature of their employments, are such as frequently render constant personal cleanliness comparatively unattainable; and, unless every possible facility is afforded for this end, they soon become insensible to its importance. The present difficulty and the labour, after a hard day's work, of obtaining water, has a very great effect on their economy, their habits, and their health. The obstacles to the maintenance of domestic or personal cleanliness soon produce habits of personal carelessness, which rapidly lower both the moral and physical condition of a whole population." "But," add the Commissioners,† "were the supply ever so abundant, no supply will effectually promote habits of cleanliness amongst a population, unless it is readily accessible at all times, without trouble."

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* Second Report, vol. i. p. 83.

† Second Report, vol. i. p. 92.

Intermittent supply demoralizing.

62. Fifthly. But while the Commissioners state that a scanty supply is inseparable from the intermittent mode of supply, that this scanty supply renders the maintenance of domestic and personal cleanliness impracticable, and that this want of cleanliness rapidly lowers both the moral and the physical condition of the population, they also point to another mode in which the intermittent system directly leads to the demoralization of the people. They say,* "Where many persons are collected, as frequently happens, quarrelling naturally ensues for precedence, while serious injury is often inflicted upon the morals of the better portions of the population."

Dr. Playfair states:† "The quarrels which ensue on the collection of water from taps common to many houses are found to be very injurious to the morals and peaceable disposition of the poorer classes; so much so, indeed, that Mr. Rushton, the police magistrate, states that a large proportion of the cases of assault brought before him are traceable to the disputes engendered by this mode of supply."

"There is a great advantage," says Mr. Hawksley,‡ "in the removal of the assemblages round the public pumps. At Newcastle-on-Tyne, where they have common fountains, and where young girls are brought into contact with every description of characters, the effect is highly objectionable."

"Among the evils of an intermittent supply to the people themselves," says Mr. Quick,§ "are the loss of time in waiting for what they call their turns, and the demoralization from the numbers brought and kept together. I have seen as many as from twenty to fifty persons with pails, waiting round one or two stand-pipes. Then there is quarrelling for the turn; the strongest pushing forward, and the pails, after they are filled, being upset. In the winter time, the inconvenience is increased by the liability of the cock being frozen, and injuries to the health from the weather and getting wet-footed."

Intermittent supply expensive.

63. Sixthly. The intermittent supply, while it is thus inconvenient, inadequate, and demoralizing, is at the same time highly expensive.

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* Second Report, vol. i. p. 91.

† Second Report, vol. i. p. 401.

‡ First Report, vol. ii. p. 36.

§ First Report, vol. ii. p. 124.

"The expense of the tank or butt," states Mr. Hawksley,* "will in general be more than half the tenant's expense, exclusive of the cost of the communication-pipe used in the street. For example, the expenditure at Nottingham for the supply of 8000 houses amounts to about 80,000*l.*; and the cost of butts or cisterns, fitted with a ball-cock, pump, or draw-off cock, and other apparatus, would amount to 80,000*l.* more at the least, if each of the 8000 tenants were to be provided with a separate cistern or tank capable of containing water for two days' supply after the present rate of consumption. Of more than half this cost the public is disburthened by the introduction of the system of constant delivery; so that by keeping the pipes constantly full, more than one-half the tenant's expense, that is, more than one-third of the total expense of introducing water into houses, is avoided."

"Before water was laid on in the houses at Nottingham," continues this witness,† "the poorer classes were accustomed to purchase water; the water was sold by carriers at the rate of one farthing a bucket; and if the water had to be carried any distance up a court, a halfpenny a bucket was in some instances charged. In general, it was sold for about three gallons for a farthing. But the company now delivers to all the town 76,000 gallons for 1*l.*; in other words, carries into every house seventy-nine gallons for a farthing; and delivers water night and day, at every instant of time that it is wanted, at a charge twenty-six times less than the old delivery by hand."

"Let us suppose," says Dr. Playfair,‡ "that all the houses in Liverpool are supplied with water, and that they all possess tanks for its reception, which they all should possess on the system of intermittent supply, then a capital of 91,516*l.* would be sunk in tanks alone: for it is stated in evidence that, taking one house with another, the cost of tanks, with their usual appendages of cocks and balls, is from 2*l.* to 4*l.* each. Now, for the miserable supply of two hours, three times in the week, the charge is 5 per cent. on the rental of houses below 6*l.*, a sum which we may assume to be the average rental of the poor class of cottages. On this assumption, 8*s.* 2*d.* (viz., 6*s.* for water, and 2*s.* 2*d.* interest on cost of tanks) forms the lowest sum for which a *proper* supply of water on the *intermittent* system can be obtained for a poor man's cottage in Liverpool. This sum is paid by the landlord, who remunerates himself by charging the tenant an additional rental of 3*d*. per week. Thus (I cite cases observed by myself), when the rent of a cottage amounts to about 7*l*., the water-rent paid to the Company will be 7*s*.; but the actual additional rent paid by the tenant to the landlord is 13*s*., the excess being charged to defray the interest and expensive dilapidation of water-tanks. The charges in Liverpool for a stinted and intermittent supply of water are nearly double those charged for a constant and unlimited supply at Nottingham, Ashton, and some other towns."

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* First Report, vol. ii. p. 30.

† First Report, vol. ii. p. 36.

‡ Second Report, vol. i. p. 401.

Mr. John Smith,* a large owner of cottage property in Preston, states that he has laid on water to a large number of cottages; that, had he been obliged to use water-tanks or cisterns to each house, with the usual appurtenances of balls and cocks, he could not possibly have incurred the expense; that the tenants could not have remunerated him for the outlay; that the cost of erecting cisterns, with ball-cocks, would have amounted to 180*l*., while the sum actually expended by him was only 24*l*., or 6*s*. for each house.

Her Majesty's Commissioners point out a striking example of the extravagant price paid by the poor for water supplied by stand-pipes or public wells, as this system is found in operation at Newcastle-on-Tyne. "The people there," they report,† "obtain water either from public fountains supplied by the water company, and paid for by the corporation, or from 'sale-pants,' or stand-pipes, at which the water is sold at the rate of one farthing a skeel, a vessel containing five gallons. This charge is more than four times the rate charged for a private supply to a house; and is the same sum that the water companies in some other towns charge for seventy-nine gallons delivered in the house, and always at command. It is estimated that 7,000,000 gallons, producing 1041*l*., are annually sold in this manner. Of this sum one-third (347*l*.) is paid to the persons in attendance on the pants. The mischievous operation of this system, both upon the interests of the company and the public, will be better understood when it is stated that, at the first erection of a sale-pant, and until the customers are numerous, the superintendent is paid two-thirds of the gross receipts. The eagerness to obtain water is however so great, that the payment has been soon reduced to one-third; and, notwithstanding the cost and the difficulty of obtaining the water, it is stated that a great improvement in the condition of the

* First Report, vol. ii. p. 151.

† Second Report, vol. i. p. 89.

neighbourhood has always followed the introduction of a sale-pant. The expense of a superintendent naturally prevents the establishment of a pant until the customers are certain to be numerous. A similar system prevails in the neighbouring town of Sunderland."

Supply of water in the Metropolis.

64. The metropolis is at present divided amongst nine large Water Companies, who are practically irresponsible for the quality and quantity of the water they supply, the Legislature having taken no securities for the supervision and modification of the distribution as the public interests should from time to time require. In 1830 it was stated to Parliament that the capital then invested for the supply of the metropolis was 3,310,342*l.* Since that period extensive additions have been made to this capital by the several Companies, and still the greater part of the dwellings of the poorer classes are either altogether without water, or are furnished only with a very scanty supply of unfiltered water of a high degree of hardness. According to the last returns, there were upwards of 70,000 houses without any supply of water whatever.

The present daily consumption of water in the metropolis is equal to the contents of a lake fifty acres in extent of a mean depth of three feet. The intermittent mode of supply having been universally adopted, there arises the necessity of receptacles to receive this mass of water at the times when it is pumped out, and to retain it until it is wanted. Let the mind dwell for a moment on what the expense of these vessels must be. The actual cost for butts, tanks, and cisterns, is estimated at two millions of money; and those who have attentively considered the subject believe that this estimate is too low. It has been shown that these receptacles are at once unnecessary and pernicious. On these grounds Her Majesty's Commissioners protest against the continuance of the intermittent system, and declare their opinion, that "the system of constant supply offers advantages for the introduction of water into all houses which are unobtainable by any other mode." It cannot but be useful to direct attention to the evidence on which the soundness of this conclusion is established; and the following may be taken as examples of the statements and opinions of the chief authorities on the subject.

Constant supply at high pressure preserves the purity of water.

65. *First*, by the mode of constant supply at high pressure, the water is preserved in a state of purity. "All the evils arising from the want of proper receptacles for water," says Mr. Hawksley,* "from neglect

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* First Report, vol. ii. p. 80.

in cleaning the tanks and water-butts, and from the accumulation of soot, dust, and other impurities in them, are completely removed by keeping the pipes constantly full. The effect of this arrangement is to substitute one large reservoir or tank well constructed, well situated, and under effectual care, for the many thousand ill constructed, ill placed butts and tanks requisite to afford a copious supply on the common arrangement. It also prevents the impregnation of water with gas, which often takes place when the water is supplied on the intermittent system."

"A never-failing and uninterrupted flow direct from the main," says Dr. Playfair,* "is not liable, as in the case of collected water, to acquire a temperature unpleasantly high, and is secured from the absorption of vitiated air and unpleasant effluvia, to hasten the decomposition of the small amount of organic matter generally existing in water."

Saves room in dwelling-houses.

66. *Secondly*, by the mode of constant supply at high pressure, the room occupied by the receptacles for water is saved; and all the witnesses examined on the point agree in representing this as a consideration of great importance in reference to the small houses of the poor. It is stated indeed† that in many houses there is no room for butts or tanks, the houses having no yards at all, and that great numbers are built back to back.

Where there is no convenience for a tank in the upper part of the house, it is stated by Mr. Hawksley, that people are sometimes driven to the necessity of placing it in the lower apartment; that then the water must be borne up-stairs for use, and that the labour induced necessarily restricts the free employment of the water for many purposes for which it is required, and in which it would be conducive to health and comfort. "In such places too," he adds,‡ "the expense of a force-pump to charge tanks for water-closets, and of waste and warning pipes, is sometimes necessary. This apparatus for the middle and higher class houses is not only very expensive, but liable to be often out of repair, constantly bringing the plumber into the house."

Dr. Playfair § also insists on the great advantage of dispensing with the costly tank; subject to dilapidation, and taking up as it does much space in the already too small dwelling of the working-man."

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* Second Report, vol. i. p. 408.

† Evidence of Mr. Liddle, First Report, vol. i. p. 106.

‡ First Report, vol. ii. p. 30.

§ Second Report, vol. i. p. 408.

Mr. Thomas Cubitt says,* "I would give every possible facility to the Water Companies to induce them to give a large supply; and I should go to this extent, that if any new Bills for Water Companies were brought in, it should be one of the obligations that their mains should be always filled; and people living in any house should always be able to get it from the mains—they should be allowed to draw off any quantity they wished: that would tend very greatly to the improvement of London."

"I wish to add my testimony," says Mr. Hickson,† "to that of every practical man who is acquainted with the poorer class of habitations, that a greater blessing could scarcely be conferred by Government upon the working classes of London, or one more essential to health and comfort, than that of a cheap and abundant supply of water; and that the present mode of supply is about the most expensive and inefficient that can be devised. The East London Water Works, for example, give their supply at such a low pressure that it will not reach a cistern on the first floor of a fourth-rate house. This fact, or perhaps my ignorance of it, together with the Company's regulation, that no two tenements should be supplied from one cistern, has very recently caused me to incur a loss of nearly 30*l*. It appears to me, that with the inexhaustible resources of water at our command, and the great mechanical powers we now possess, there is no adequate reason that water should not be supplied to the top of every house in London."

Saves time an labour.

67. *Thirdly*. The mode of constant supply saves the time and labour of fetching and carrying water, and removes the evils arising from the assemblages of people at the public pumps.

Is less expensive.

68. *Fourthly*. The mode of constant supply is less expensive than any other, and for the following reasons.

This mode of supply saves the cost of the receptacles for holding water, and the constantly recurring expense of keeping them in repair.

Requires smaller mains and pipes.

The whole of the apparatus required for the delivery of the water is less expensive on this than on the intermittent system. It was urged as an objection against the general introduction of the system of constant supply at high pressure, that it would render the employment of much larger mains and pipes for the distribution of the water indispensable. Among others, Mr. Wicksteed, the engineer of the East London Waterworks, strongly insists on this objection. On examining into its solidity, Her Majesty's Commissioners put the following question to Mr. Hawksley*—"What," ask they, "is the evidence of fact and experience as to this point?" Mr. Hawksley answers:—"Directly the reverse of the hypothesis. If the supply of water for ordinary purposes be the only consideration, then, for the same reason that smaller pipes do suffice for the tenants' communication-pipes, smaller mains will suffice for the system of constant supply at high pressure. Where 20 inch mains are used on the system of periodical supply, 12 inch mains would amply suffice for the system of constant supply; instead of the 7 and 6 inch mains, 5 or 4 inch would suffice; instead of 3 inch service-pipes for the occasional supply, 2 inch would suffice for the constant supply; indeed, for constant conveyance, sizes *much* smaller than these would answer the purpose; but as there are irregularities of draught, it is needful to provide accordingly. The *objection* of Mr. Wicksteed is founded upon a supposed state of things which never does occur, namely, of all the pipes discharging water at *the* same time."

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* First Report, vol. ii. p. 272.

† First Report, vol. ii. p. 237.

This witness further states,† that the pipes in the metropolis, and other places where the Company's supply is only occasional, are larger than necessary, that the water may be delivered within a stated time; that in towns the usual size of the tenants' pipes is three-quarters of an inch, and in the larger houses one inch: whereas, with the constant supply, half-inch pipes will serve the same purpose; that, in like manner, the diameter of the service-pipes and sub-mains are, on the system of constant supply, diminished about one third, and the weight of the pipes about one half; and he adds that, in point of fact, the amount of pressure does not practically enter into the determination of the thickness of the metal of the main pipes,‡—"any thickness at which mains can, in the regular course of foundry business be *cast*, will afford many times the strength requisite to retain water under a pressure of 150 feet. In fact, pipes are proportioned according *to* the difficulty of running the metal and adjusting the core; and, in practice, it is customary to prescribe a thickness of at most one-fifth of the square root of the diameter (18 $\sqrt{d}$.), a proportion which has no reference whatever to the strain arising from the pressure. Pipes are now cast lighter than formerly, although the pressure under which water was usually transmitted has been increased."

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* First Report, vol. ii. p. 35.

† First Report, vol. ii. p. 46.

‡ First Report, vol. ii. p. 44.

Dr. Playfair* states that he has endeavoured to ascertain the validity of the objections commonly urged against the adoption of a constant supply at high pressure, by the experience of those towns which possess such a supply; and, with reference to the first objection, that stronger and larger mains and pipes are necessary, he says, actual fact and experience prove the very reverse to be the case. Thus, the manager of the Preston Waterworks being asked—"Does this pressure (160 feet) render it necessary to have larger and stronger mains and service-pipes than those used when the water is not kept at high pressure?" This witness answers,—"Quite the contrary, because the water being constantly on, and not coming at intervals, a smaller pipe is sufficient for delivery; and the pipes are not strained by a sudden gush of water. We never had a pipe which burst from a pressure of the water, but we test them beforehand to bear the pressure of 300 feet."

"The evidence of the manager of the Oldham Waterworks," continues Dr. Playfair, "is still more satisfactory, because in dry summers he *districts* the water to some of the poorer parts of the town, having it on five hours in the day, or on the intermittent instead of the continuous system. He is therefore in a position to give correct information on both systems." "Your pressure being 300 feet, do you find it necessary to use stronger pipes on the system of continued supply than on the intermittent method?" "Quite the reverse; the pipes last longer on the continued than on the intermittent system, as we find by experience in those places where we *district* our water. When they are emptied and again filled, we find that they corrode very fast; much oxide of iron accumulates in them. They require to be stronger also, to withstand the sudden gush of water; for we find that they often burst, by compressing the air, which must find a vent-hole."

High service not expensive.

The evidence given by Mr. Hawksley† proves another important fact, that the high service does not occasion much additional expense; that the extra cost of pumping to raise water to the highest point for which it is ordinarily required is very slight. "There is," he says,

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* Second Report, vol. i. p. 412.

† First Report, vol. ii. pp. 27, 28.

"but one pressure at Nottingham, and that is the same at all times, and is found to be economical. If the water were lifted only half the height, the saving would not amount to more than about one twentieth of the total charge." "Assuming," he adds, "the possibility of varying our works without cost, the experience at Nottingham is to this effect, that we could give eight or ten times the present unlimited supply for about a double charge; that we could raise all the water now taken fifty feet higher by increasing the charge five or six per cent.; and that, were we to lower the head to half the present height, the saving of expense would not exceed six or seven per cent. on the gross charge to the tenant. Thus the Trent Water Company supplies houses at an annual average charge of about 7*s.* 6*d.*, at any level required, even into the attics of four or five story buildings. If the supply were afforded to the level of the pavement only, the charge would not be reduced more than 6*d*, per house, or for the labourer's tenement not more than 4*d.*"

Constant supply requires fewer officers.

69. It was further objected to the mode of constant supply, that it requires a larger number of officers to prevent waste of water, and to superintend the general management of the works; but the evidence proves the practical fact to be directly the reverse.

"The management is much more easy," says Mr. Hawksley,* "and the number of men necessary to superintend the distribution of the water becomes much fewer; in fact it demands very little attention indeed when the water is constantly running through the pipes; but when the water is given at intervals, many persons are put to great inconvenience: then they are complaining, and must be attended to; and the ball-cocks when they go down will stick very frequently, and there is consequently a great waste of water, so that a great quantity of water is not well applied. The waste is very great on the intermittent supply; much more, I am satisfied, than most engineers are aware of. We have found, in many instances, when our supply has been turned off a particular street for a short time, the ball-cock of a cistern has gone down, and the water run to waste after having been turned on. That happens in all towns where the supply is intermittent; and I believe the waste from this and some other causes is much greater than that which occurs in a constant supply."

"The constant supply," continues this witness,† "is the means of a large economy of men. Our company has maintained its supply by night and by day ever since its establishment, except during a period of one month, when, for the purpose of experiment, the water was shut off at ten in the evening, and turned on again at five in the morning. It was then found that it would be more expensive to keep extra turncocks, do extra repairs to valves, draw plugs to cleanse the pipes, and attend to complaints. The original plan was therefore resumed. We find that one experienced man, and one boy of about eighteen years of age, are, on the system of constant supply, quite sufficient to manage the distribution of the supply to about 8000 tenements, and keep all the works of distribution in perfect repair, including cocks, main-pipes, service-pipes, and the tenants' communication-pipes, to the extent they are laid under the public highways."

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* First Report, vol. ii. p. 46.

† First Report, vol. ii. p. 33.

Prevents waste of water.

70. Dr. Playfair* states that the uniform experience at Oldham and Preston is, that a constant supply economises water; that in this system there is very little waste; that complaints are seldom made of unnecessary waste, though the superintendents are active in searching out grievances of this kind, and that in fact high pressure renders a running tap a great nuisance, from the noise it makes; that at Preston there is only one turncock, who is sufficient for all purposes; that all the cocks and valves in Oldham are also managed by one man, who is found quite sufficient; but the manager states that if he had much to do with the intermittent system, he would require three or more. He adds,—"I have not the slightest doubt as to the superior economy of the system of constant supply."

Acts as its own police.

71. In their examination of Mr. Hawksley, Her Majesty's Commissioners† say,—"An objection to the introduction of water into the houses of the poorest classes is thus stated by Mr. Wicksteed:—'When a landlord has got twenty, or thirty, or forty, or fifty houses, and requires a supply of water, if they are poor houses, it is frequently given by one common standcock to all the houses. If he was to put a separate supply to those houses by a lead pipe, the lead pipe would be there in the evening, but would be gone in the morning.' 'Now, do you find that the tenants are apt, for the sake of the lead, to cut off their own supplies of water; and what, under all circumstances, is your own experience on the point?' 'We have some of the poorest and worst conditioned people in Nottingham, and we scarcely ever experience

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* Second Report, vol. i. p. 413.

† First Report, vol. ii. p. 35.

anything of the kind.' In fact, the water at high pressure serves as a police on the pipe. The cutting of a cock, with the water at high pressure, is rather too difficult a matter to do quietly: knocking up is too noisy; when a knife is put into such a pipe, and a slit is made, a sharp, flat, wide stream issues, very inconvenient to the operator; and when the pipe is divided, there is a full rush of the jet to denounce the thief. We have lead pipes all over the town, in the most exposed places, and I can affirm that such an event rarely occurs *out* of the houses, and never *within*.'"

"It has been stated in evidence," says Dr. Playfair,* "that it would be impracticable to lay on water into the houses of the poor; for, if a leaden pipe were introduced, it would be there in the evening and gone in the morning." This general charge of theft I find unwarranted by actual experience. In Preston and Oldham there are no stand-pipes, the water being always laid on in the houses, and in the former town the pipes are unnecessarily exposed, and yet, in the experience of ten years, only two cases of theft have occurred to the total amount of 15*s*., and one of these was in an unoccupied house. In Oldham, with an experience of seventeen years, the manager never heard of one case of theft. Thefts of this kind, if at all to be feared, are much more likely to occur on the intermittent than on the continuous system, for the water acts as its own police, and betrays, while it drenches, the thief."

Costs only one penny per week.

72. The result of the whole is, that, from the arrangements and economies of the system of constant supply at high pressure, an unlimited quantity of filtered water is afforded at every moment that it is needed, night and day, at the cost of one penny per week.'

Thus Mr. Hawksley states that,† "Water is given into the houses of the labouring classes, on the system of constant supply at high pressure, at Nottingham, at the cost of one penny per week; that a two or three story house, of three rooms, is supplied for this sum; that at this charge tenants have any quantity of water they choose to take; and that more than five thousand houses inhabited by the poorer classes are supplied in this manner, the tenants being charged by the owners one penny a week, in the shape of additional rent, and this sum giving the Company its fair interest and remuneration for a constant and unlimited supply of filtered water." "I think," adds this wit-s,* "I had better explain that the Water Company obtains from e landlord an account of the rent of each house, and takes 1*s.* in the ound of the rent, and allows the landlord a discount of 25 per cent. which reduces it to 9*d.* in the pound on the rent) to cover any inci-ental losses he may sustain. Supposing a house were let at 6*l.* a ear, 2*s.* 4*d.* a week, the Company's first charge would be 6*s.* a year; ut then the landlord would receive back again an allowance of 1*s.* 6*d.*, hich would reduce the charge to 4*s.* 6*d.*, and practically the landlord ould increase his rent 1*d.* per week; so that, probably, by that rangement he might lose by each tenant 2*d.* in the year."

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* Second Report, vol. i. p. 411.

† First Report, vol. ii. p. 35.

According to Mr. Robert Thom,† who for the last thirty years has aid attention to the mechanical means of supplying towns with water, nd who has himself supplied, among other towns, Greenock, Paisley, d Ayr,—"a supply of two cubic feet of water, or about thirteen allons per diem for every individual of the population is afforded at he following charges:—At Campbelltown, a family of five indi-iduals, at the rate of about 1*s.* 4*d.* per annum; at Ayr, 2*s.* 2*d.*; at aisley, 2*s.* 9*d.*; at Greenock, 2*s.* 6*d.*—five per cent. being allowed r the capital employed, and the expense of wear and tear, and the harge for superintendence and the like being included in the stimate."

"If," says Dr. Playfair,‡ "the unstinted and constant supply of water be essential to cleanliness, and, indirectly, to a healthy tone of society among the lower orders, as few will be inclined either to dispute or to deny, it becomes an important question how the benefits of this essential necessary of life can be best extended to every person in a community. Of course the best means are the most economical; for, wherever much expense must be incurred in an improvement, many obstacles are immediately presented to its execution. Now here the advantages of the natural system are very obvious; for, instead of having to provide tanks, at an average expense of 2*l.* to each cottage, and a communication-pipe, generally at a cost of 1*l.* more,—by the natural system, and by a few judicious improvements on it, the total expense never amounts to one-sixth of this sum, and is generally considerably less. In Preston the average cost per tenement is from 5*s.* 6*d.* to 6*s.*, and in Oldham it is 7*s.*"

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* First Report, vol. ii. p. 47.

† First Report, vol. ii. p. 7.

‡ Second Report, vol. i. p. 409.

Is universally practicable.

73. *Fifthly.* The evidence further shows that the mode of constant supply is universally practicable.

"Thus," Mr. Hawksley* states, "that any company that possesses an ample quantity of water at its works, and a sufficient reservoir in an elevated situation, may adopt this mode of supply without difficulty or disadvantage, and indeed the difficulty and disadvantage is far from insuperable when an elevated reservoir cannot be obtained." On being asked—"Do you conceive that the high pressure could be engrafted on the present system in London, without a very material difficulty in point of expense?" This witness answers,—"I think it might, particularly if the supply were constant. I think there would be no difficulty in the arrangement."

As the result of a careful calculation, Mr. Hawksley† further states, "that, supposing the daily supply of the metropolis to be equal to a lake of fifty acres, of a mean depth of three feet,‡ a first investment of 15*s.* per head, or 9*d.* in addition to the annual water charge of each of the population, would enable a constant supply of the purest soft water to be delivered at all hours, into every story throughout London, and that without injury to the interests of the existing companies, who might derive their supplies from this common source. A very considerable economy of management and working expenses would indeed result from this consolidation of engineering operations, which would go far in reduction of the increased charge of 9*d.* per annum." He also shows § that a constant supply of pure and filtered water might be brought from Windsor to the metropolis at a charge not exceeding 2*d.* per week per house, one with another, or at 1*d.* per week for the lowest class of tenements.

Mr. Joseph Quick,‖ engineer of the Southwark Water Company, states that he entirely concurs with the evidence given by Mr. Hawksley, as to the practicability and great advantage of substituting a system of constant supply, night and day, at high pressure for the present system of intermittent supply; that he has calculated the additional expense that would be incurred per week per tenement for such an increased supply within the district supplied by the Southwark Water Company; that this expense would be three half-pence per week; and that a large proportion of this extra expense would ultimately be saved by dispensing with the necessity of the water-butt and tank, and all the expense connected with their wear and tear, and their repairing, renewing, and cleansing.

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* First Report, vol. ii. p. 38.
‡ First Report, vol. ii. p. 60.
† First Report, vol. ii. p. 34.
§ First Report, vol. ii. pp. 40—48, 59, 60.
‖ First Report, vol. ii. pp. 114, 115.

"If the butt were got rid of," inquire the Commissioners, "by the system of constant supply at high pressure, supposing adequate powers were given, and the water were laid on by the Company, at what expense per tenement could it be done?" This witness answers: "I believe that with iron pipes it might be carried up to the first floor at an outlay of from 20*s.* to 25*s.* per tenement; that is, for a four-roomed house. A further economy might be effected by carrying up one service for two houses, and making branches from it."

Mr. W. C. Mylné, the engineer of the New River Waterworks, gives * similar testimony as to the perfect practicability of making such a modification, at least of these waterworks, which at present supply 900,000 inhabitants of the metropolis, as would meet the exigencies of any service that could be demanded, and "at a comparatively inconsiderable distributory expense." Her Majesty's Commissioners, in their examination of this witness, request of him an answer to the following statement:—"The Commissioners have received evidence as to the public wants, and especially of the wants of the poorest classes of the population; and as to the practical operation of an extended system of supplies in different towns; from which it appears to be desirable—That the system of supply for the poorer classes of houses by common cocks or tanks for several tenements should be superseded by an extended system of supply carried into every separate tenement. That the system of periodical or intermitted supply should be generally extended to one of constant supply at all times, night and day, and kept on at high pressure, as in several towns and places, so as to supersede the necessity of having, and keeping in good condition, water-butts or tanks, so as to be used also early in the morning for cleansing and watering the streets, and at nights to be in immediate readiness on the application of a hose, to be thrown over the houses in the event of a fire. Assuming it to be desirable and necessary to meet the public wants in these respects, and carry out such a measure, do you think that the requisite supply could be rendered by the New River Company?"—This witness replies: "There could be no difficulty whatever in increasing, AT A COMPARATIVELY INCONSIDERABLE DISTRIBUTORY EXPENSE, the supply of water through the existing works, perhaps even to an extent beyond that which might be required, provided the Company were empowered to take that quantity out of the river Lea, or from the Thames—the latter, however, is subject to much objection as to quality; and at present the quantity from the Lea is limited. Yet it is my opinion that by improvements that might be made in the navigable channel of the river Lea, and by making equitable compensation to the millers where any loss of power might be occasioned, sufficient water of the quality of the New River may be obtained for the public service, and no injury occasioned to the navigation."

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* First Report, vol. ii. pp. 113, 114.

"Persons residing in London," says Dr. Arnott,* "are not so well supplied as the inhabitants of New York, where a river of water has lately been conducted into the town, giving four times as much water to about 400,000 inhabitants as enters London for about 2,000,000; but it would be quite possible here to increase, to any amount, the quantity of excellent water taken from the Thames at a suitable distance above the town."

Poor willing to pay.

74. *Sixthly*. It is further proved in evidence, that whatever may be the additional cost of affording this constant supply, the poor at least will willingly pay their share of it.

"Landlords and tenants," says Mr. Hawksley,† "equally require a supply of water, which the Company affords uninterruptedly. When the Company introduced the uninterrupted supply at Nottingham, the poorest tenants required it of their landlords. The landlords then said, 'If you will consent to pay an additional penny per week of rent, we will try to arrange it with the Company.' This was the case in thousands of instances. The charge was in these cases made upon the landlord, and he put it upon his rent, and the tenants most cheerfully paid it."

"I have a strong objection," adds this witness,‡ "to supply the poor, in respect of their dwellings, with any article at a lower rate than that at which it is supplied to their more wealthy neighbours; for the difference passes in a very direct manner into the pockets of their landlords, who are thereby enabled to let their houses at a higher rent in they could otherwise command. If, for instance, the house I cupy were to be disburthened by Act of Parliament from the rates l taxes with which it is now charged, the owner would immediately tain a rent higher by at least the full amount of the exemptions. It s lately become the fashion to pacify the presumed opposition of the rking classes (which is in reality commonly the opposition of the all owners) to proposed local Acts, by inserting clauses to exempt m from the operation of rating enactments; a fashion which, while loes not benefit the working classes to the extent of sixpence, has effect of compelling the non-holders of cottage property to subbe unjustly to the rental of others, the holders of such property. e attention of Parliament, it appears, has not yet been attracted to s abuse."[*]

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* First Report, vol. i. p. 62.

† First Report, vol. ii. p. 39.

‡ First Report, vol. ii. p. 38.

Mr. Thomas Ashton,[*] manufacturer at Hyde, who has introduced ter into about three hundred and twenty houses occupied by his ourers, being asked "Has the change of practice given satisfaction your tenants?" answers, "I know no alteration that has given so ch; there is never any complaint in paying for the water. They r they save money by it; that the saving in cans and tubs, which re continually broken, would almost pay the expense."

"There is much concurrent evidence," says Dr. Playfair,[†] "to ove that there is no boon more highly prized by the poor than an stinted supply of water, and that there is no necessary for which ey would more willingly pay a fair and adequate price." The evince of Mr. Thomas Sumner, an intelligent collector of water-rents Preston, may be cited: "Do you find much difficulty in procuring e water-rents from cottage property?" No, they come in pretty ll, according to the times; generally speaking, we have not much ouble. Cottage inmates are particularly well pleased to have water d on into their houses, and do not seem to have any objection to pay r it. Those who have been accustomed to the supply of water find e benefit of it so great that they will not live in cottages where it is t laid on; and they value it so highly, that a threat to cut off their pply causes a speedy payment of the arrears. On this account we ve very little loss in the collection."—"Do you know exactly the nount of loss; does it exceed three per cent.?"—"I cannot say presely, but I believe it is much under three per cent." "From your experience as a collector, are you of opinion that, if the legislat compelled water to be laid on to each cottage, the inmates woul object to the additional rental thus occasioned?"—"I believe that th would not; indeed, I am sure that they would be very willing to the additional rent."

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[*] First Report, vol. ii. p. 99.

[†] Second Report, vol. i. p. 410.

"Having been informed," says Mr. Toynbee,* "of the practicabili of laying on pure water constantly, at a penny a week, I have aske great number of the patients whether they would consent to pay additional rent of 2*d.* a week to have the water laid on in their roo and they have expressed warmly their willingness to pay even mor that such payment would be but a trifle for such a 'blessing' as th have termed it. They have not complained, because they nev imagined the practicability of any amendment."

"I can state a circumstance," says Mr. Liddle,† "to show ho much they appreciate the convenience of having water brought into th premises. In a place in Cartwright-street, where there is a numb of small tenements surrounding a piece of waste ground, which tene ments are occupied entirely by the labouring classes, a well has recentl been sunk by the landlord, and a large tank erected over the wel This tank is filled by horse-power. From this tank pipes are carrie and the water distributed into several houses. I may mention, a evidence of their appreciation of the supply, that they now pay 3*s.* 6 per week as rent, in lieu of 2*s.* per tenement, which they formerly pai It appears that these houses were for many years, in the opinion of th landlord, underlet; but the tenants consider that the increase of t rent arises from the supply of water."

"I would willingly pay from 6*d.* to 9*d.* per week," says a poo labouring man,‡ "if water was laid on in my room; it would be a grea saving of time and expense; for if I want a cup of coffee in the morning, I am obliged to get up and fetch the water from a distance, or el to go to a coffee-shop, where I am charged more than it would co me at home." He further described the condition of the court in which he was living by stating: "There is but one privy, which i always in a filthy state. I am frequently obliged to clean it myself, which is a most filthy job. I would willingly pay a sum weekly fo the convenience of a water-closet for myself and family, to be save e very unpleasant labour of cleaning the common privy in turn. If iter were laid on in the house, all of us labouring men would keep irselves much cleaner, and our houses would be much cleaner. The bour of fetching the water is the principal reason why the houses are it kept clean. The water which we keep in the house in tubs soon ecomes spoilt and unfit to be used as drink. I would willingly pay penny a-week to have the court and outside of my house kept ean."

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* First Report, vol. i. p. 85. † First Report, vol. i. p. 107.

‡ Mr. Liddle's Evidence. First Report, vol. i. p. 103.

Constant supply an effectual protection against fire.

75. Thus far the superiority of a constant over an intermittent supply f water has been argued chiefly on the ground of the public conve-ience and health; but it is equally advantageous with a view to the rotection of property. It is the certain and the only efficient means f arresting the devastation of fire. It is stated by Mr. Hawksley,* hat wherever there is a constant supply of water at high pressure, it s easy, in the space of two minutes after the first alarm of fire, to ring water at the rate of thirty gallons a minute to bear upon any ouse in which a fire occurs. On the other hand, it is found that in ountry towns, at least, the average space of time before a fire-engine an be brought to the spot and set to work is half an hour. It is stimated that when the fire broke out in the Exchange at Nottingham rater at the rate of 120 gallons per minute was poured upon the flames nd all around the building, and it is considered probable that, but for this quick and ample supply, the fire in question would have been as extensive as the recent fire at Hamburgh.

Mr. Joseph Quick states† that under this system of constant supply at high pressure, even the smallest street might be supplied with a three-inch main, affording at least one 40-feet jet, which is equivalent to keeping the power of one engine and twenty men at every door, to act at one minute's notice after the first alarm of fire.

Mr. Robert Thom gives similar evidence,‡ and says that no town ought to be considered fully supplied with water unless the pipes are kept constantly full, and arrangements are made by which a powerful force of water can be taken from them at a minute's notice to extinguish fire at any part of the town, high or low.

Use of fire-engines superseded.

At Preston, for the last three or four years, the use of fire-engines has been entirely discontinued. On an alarm of fire the practice in this town is instantly to screw a hose to a plug, by means of which water can be thrown to the top of the highest building. For the sum of 2*l*. each plug can be fitted up so as to admit two hoses to be screwed to it, and thus to furnish two jets; that is to say, for the sum of five pence per annum every house in this town can be supplied with arrangements for the extinction of fire equivalent to four engines kept constantly at its door for its own exclusive use. The practice and experience at Oldham is the same. "In five cases out of six," says Mr. Emmott,* the manager and engineer of the Oldham water-works, "the hose is pushed into a water-plug and the water thrown upon a building on fire, for the average pressure of water in this town is 146 feet; by this means our fires are generally extinguished, even before the heavy engine arrives at the spot. The hose is much preferred to the engine, on account of the speed with which it is applied, and the readiness with which it is used; for one man can manage a hose and throw as much water on the building on fire as an engine worked by many men. On this account we very rarely indeed use the engines, as they possess no advantage whatever over the hose."

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* First Report, vol. ii. p. 65.

† First Report, vol. ii. p. 133.

‡ First Report, vol. ii. pp. 2—11.

Saving on Insurance.

76. Availing themselves of these arrangements, many manufacturers have water laid on in every story of their factories, with plugs attached and the hose in constant readiness; and some have water laid on even in every room. In one of these instances† "the pipe terminates in a transverse tube, at both ends of which there are hollow iron cylinders perforated with holes, and capable, when the water is turned on, of throwing the water with great force, and deluging every part of the room. The pipes are so arranged that the watchman at the bottom of the outside wall of the building, by simply turning a cock, can throw an unlimited quantity of water into every corner and crevice of the room on fire."

In consequence of the increased security afforded by these arrangements, many of the mill-owners have ceased to insure their property. In the case just mentioned, in which water is carried into every room of the factory, the cost of fitting up the apparatus was 150*l*., and 4*l*. per annum is paid for the supply of water. The owner of this factory was accustomed to pay for the insurance of his mill 200*l*. per annum, which insurance he now discontinues; so that for an annual charge of 14*l*. he obtains the same or greater security against loss by fire as he

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* Second Report, vol. i. p. 406.

† Second Report, vol. i. p. 406.

by the annual payment of 200*l.*[*] But the expense of fitting up a
ehouse with plugs in each story only is from 25*l.* to 30*l.*,[†] a guinea
ually in addition being charged for the supply of water; so that
total annual cost is about two guineas. Now the insurance of the
llest class of warehouses amounts to 20*l.*, and many pay from 500*l.*
00*l.* In Manchester the saving of insurance on sixty-six thousand
ses is 20,000*l.* per annum; in the metropolis it would be much
ve 100,000*l.* It is stated by Mr. Holland, that the actual destruc-
of property in Manchester by fire considerably exceeds 20,000*l.*
ear. According to the police returns the estimated value of pro-
ty destroyed by fire in Manchester during the last five years is
,305*l.* 8*s.* 3*d.* From the facts just recited it must be regarded as
ery moderate estimate which assumes that at least one-third part of
t destruction would be prevented by a constant supply of water at
h pressure. It is probable, indeed, that the saving of property by
diminution of the loss by fire would be equal to half the entire cost
the water supply.[‡] On these grounds Her Majesty's Commissioners
ommend[§] "that for increasing the protection of property from fire,
all cases the supply of water in the mains be not only constant, but
o at as high a pressure as circumstances will permit, and that fire-
gs be inserted in the mains at short intervals."

Recommendation of Her Majesty's Commissioners.

Constant supply should be made compulsory.

77. From the whole, then, it appears that the public interest, and
re especially the welfare of the poorer classes, absolutely requires
t the mode of intermittent supply should be abandoned, and that the
stem of constant supply at high pressure should be generally intro-
ced. It has been proved by incontrovertible evidence that this con-
nt and high service is the most economical, and that it is also uni-
rsally practicable; and yet the public have no power to enforce its
neral adoption. This, therefore, is a case in which the public, and
pecially the poorer classes, being wholly unable to protect themselves,
quire legislative aid. A water company is a trading body, investing
pital, with a view to profit, in a public work. For the better per-
rmance of this public work they ask the legislature to grant them

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[*] Second Report, vol. i. p. 407. [†] Second Report, vol. i. p. 406.

[‡] It is surely desirable that the inhabitants of Liverpool should make an estimate
the actual amount of money they would have to pay for an unlimited supply of
tered water, delivered at high pressure to every house in the town, *beyond* the sum
ey annually lose by their frequent and dreadful fires.

[§] Second Report, vol. i. p. 103.

certain privileges and powers. If the legislature grant these privileges and powers, it has an undoubted right, and it is its duty, to tak securities for the due performance of the public service in questio That service in the present case can be duly performed only on one condition, namely, that the supply of water be constant and at high pressur Your Committee therefore submit that no water company ought i future to be established under legislative sanction without the stric enforcement of this condition.

Compensation to Water Companies.

78. For the same reasons they are of opinion that all existing wate companies ought to be required, within a reasonable time and on du compensation for loss, to modify their works in such a manner as enable them to introduce the system of constant supply at high pre sure. The trouble and expense which the change from the intermi tent to the constant service may in some instances occasion, ought n in the opinion of your Committee, to prevent the legislature fro making the change compulsory, both because it is proved that th change can generally be effected not only without ultimate loss, but wi positive benefit to the companies themselves, considered even as tradin bodies; and because provision might and should be made for the co pensation and protection of proprietors where such compensation a protection can be proved to be just. But on no principle of justic can the community be taxed in perpetuity to defray the expense former ignorance, waste, extravagance, and jobbing; and under circumstances ought the public health and property to be sacrificed the representations of parties interested in the maintenance of a syste proved on the fairest and fullest investigation to be vicious. It is su mitted, therefore, that all existing Companies should be compelled the Act to adopt the mode of constant supply, at as high a pressure practicable, by alterations of their works approved of by the Inspect After sufficient experience, suppose after an experience of th years, they should be entitled to have any loss, which they may be a to prove they have sustained, made good to them out of the rate. I general there would be no loss, but if there be, it is clear that it sh be thrown not upon the Company but upon the community.

Clauses of the Bill to be omitted.

79. For these reasons your Committee submit that the followin clauses in the proposed Bill, which, so far from condemning a prohibiting the intermittent supply, actually recognise and perpetu it, should be omitted:—

“ And be it enacted, That every person supplied with water under e provisions of this Act, *unless* such supply shall be constant, shall, required by the said Commissioners, provide *a proper cistern to ceive* and retain the water with which he shall be so supplied, with a ll and stop-cock affixed to the pipe conducting the water from the orks of the said Commissioners to such cistern, and shall keep *such stern*, ball, and stop-cock in good repair, so as effectually to prevent e water from running to waste; and in case any such person shall glect to provide, when required by the said Commissioners, such stern, ball, or stop-cock, or to keep the same in good repair, it shall lawful for the said Commissioners, or for any person acting under eir authority, to turn off the water from the premises of such person, ntil such cistern and ball and stop-cock shall be provided or repaired, the case may require.

“ And be it enacted, That if any person supplied with water by the id Commissioners shall suffer *any cistern*, or other receptacle for ater, pipe, or cock belonging to him to be out of repair, so that the ater supplied to him by the said Commissioners shall be wasted, he all forfeit for every such offence a sum not exceeding five pounds; nd it shall further be lawful for the said Commissioners to repair any ch cistern, receptacle for water, pipe, or cock; and the expenses of ch repair shall be payable by the person so allowing the same to be ut of repair, and be recovered in the manner hereinafter provided for covery of the water-rate.”

Water should be filtered, or sufficient area of depositing-bed provided.

80. As experience shows that nothing will be done for the public in- rests, or at least that no reliance can be placed on anything being one for them which the law does not positively require, your Com- ittee further submit that compulsory provisions should likewise be ade either for the filtration of all river, hill-side, and drainage aters, or for the formation of a depositing bed of sufficient area to dmit of the settlement of impurities.

Expense of filtration.

Where the latter plan can be adopted it is generally conceived to be he best; but when it cannot, the filtration of water can always be erformed on a large scale with the utmost ease, and at a trifling xpense. It is fully established in evidence, that the cost of filtra- ion varies from the half to the one-sixth of a penny for 1000 gallons. Thus the cost to the Southwark Company,* for example, is the one-sixth of a penny for 1000 gallons, which for the supply of a labourer's tenement, assuming it to be 40 gallons per diem amounts to 4½d. per annum, or one-third of a farthing per week. So that at the rate of 5 per cent. interest on the fixed capital employed, making altogether 8d. or 9d. interest, and 4½d. management the total cost is little more than 1s. per annum, or less than one farthing weekly, for ensuring the purity by filtration of a supply of 40 gallons of water per diem for beverage, for culinary purposes, for washing, for baths, and for all other purposes.

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* First Report, vol. ii. p. 65, *et seq*. Ibid. 128. Ibid. 3. See also Second Report, ol. i. p. 412, *et seq*.

Lancashire method of filtration.

Mr. John Graham, partner in the print-works of Messrs. Hoyle and Sons, states that by the method adopted by them, the "Lancashire method," for the sum of 156*l.* per annum (exclusive of the rent of land) they can filter half a million of gallons daily, or one hundred and eighty-two and a half millions of gallons per annum: and that by the adoption of this method, every labourer's tenement, assuming his consumption to be forty gallons daily, could have his water perfectly clean and filtered for 3*d.* added to his annual rent. Of course, one public filter must be infinitely more economical than twenty thousand private filters, with twenty thousand different cares, cleansings, and renewals.

New Water Companies.

81. Your Committee submit that the facts and reasonings now adduced completely establish the case for which they thus earnestly contend, namely, that every water company seeking legislative aid and protection ought to be compelled by the legislature to furnish the public with filtered water at constant service and high pressure. But if it is right that the legislature should require all existing water companies to submit to this condition, and to whatever other regulations are proved to be necessary for the maintenance of the public health and the protection of public property, *à fortiori* it ought to withhold its sanction from the establishment of new water companies until the provisions are determined on which the powers and privileges sought can be granted without compromising the interests of the community. Her Majesty's Commissioners state, as the conclusions to which they have arrived from the vast mass of evidence that has come before them, that the water supply should be constant; that it should be consolidated with the works of drainage; that to separate these works is to render both inefficient, and to double or treble the expense for the construction, maintenance, and working of each. The Commissioners will therefore, indeed, have laboured in vain, if the legislature

hould listen to the applications now before Parliament; applications hich the very announcement of the conclusions of the Commissioners ppear to have suggested; schemes for the pre-occupation of towns by ater-works for trading companies, without the slightest additional ecurity for the public interests.

Insufficiency of Parliamentary regulation.

A regulation appears, indeed, to have been adopted during the last ssion of Parliament, that the water companies then sanctioned should e subjected to any future regulations that might hereafter be made in spect to such companies. But the subjection of these companies to ture regulations will not prevent them from making large claims for ompensation for the alteration of their first arrangements. Yet unless he sites of the proposed sources of supply, unless the extent and contruction of the reservoirs, be inspected by a competent and disinterested fficer, such as the Bill proposes to appoint, neither the legislature nor he public can have the slightest security that the whole outlay, that he entire works will not be ineligible, will not be utterly inapplicable the comprehensive and combined system of works recommended by Ier Majesty's Commissioners.

Sheffield Water Company.

82. As an example of the danger of passing a measure permissive of ach unregulated schemes of separate works, though it may contain a roviso subjecting the company to future regulations, your Committee eg to direct attention to the state of things existing at the present oment in the town of Sheffield.

From evidence given by Mr. Hawksley, it appears that if from 0,000*l.* to 100,000*l.* had been properly expended on the water-works for he town of Sheffield, an abundant supply of filtered water might have een obtained. Upwards of 100,000*l.* had, however, been there exended for an intermittent supply of unfiltered water, which one of Ier Majesty's Commissioners—Mr. Smith,* of Deanston,—reports to e of a very bad colour. By means of the monopoly of this supply he company obtained excessive water-rates and a high premium for heir shares.

During the last session they obtained power to raise another capital f about 100,000*l.*, and to invest it in the extension of these same imerfect works, for the imperfect, that is, the intermittent, supply of nfiltered water. A number of the leading inhabitants are desirous of arrying out the measures of improvement recommended by Her Majesty's Commissioners. They desire a constant supply of filtered wate they desire complete house and street drainage; they desire the co lection and application of the refuse of the town to agricultural pr duction. But they now find that to obtain the supply of water th need they must expend at least another hundred thousand pounds, t do that which might have been perfectly done with the first hundr thousand pounds already expended. Now, however, to obtain the re quisite permission to effect these objects, they must enter into desperate and most expensive conflict with the shareholders of th capital wasted, for want of proper precautionary measures to ensur good works in the first instance; or this wasted capital must be pai for by the promoters of the improved works; and those works mus be saddled with a rental which will prevent the voluntary use of the improved supply of water by the poorer inhabitants.

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* Second Report. vol. ii. p. 155.

Cesspools.

83. Her Majesty's Commissioners, in their First Report, say,* "Th medical witnesses have brought before us facts in support of thei strongly urged and unanimous opinion, that no population can b healthy which live amid cesspools, or upon a soil permeated by decomposing animal or vegetable refuse, giving off impurities to the air i their houses and in the streets." In their Second Report they add,† "Many instances occur where the walls of the adjoining houses ar constantly wet with fetid fluid, which frequently affects the atmospher of the rooms so as to render it impossible to keep food for one singl night without its becoming tainted. The walls of the house recei considerable damage, and the foundations are completely saturated wit the foul water that percolates through from the cesspools. The de terioration of property from this cause is very considerable."

Pollute
Springs and
Wells.

84. It is stated in evidence that the springs and wells are constantl polluted by the same cause. "As houses are built and neighbourhoods become more crowded," says Mr. Joseph Quick,‡ "the pollution of the springs by the permeation of matter from cesspools becomes greater. They have now got into a mode of deepening the cesspools until they come to the first stratum of sand, six, eight, or ten feet. This cutting generally carries the cesspool into a spring, and relieves the cesspool of the liquid portion of the refuse, which is carried away b the spring into any lower level. On making a new sewer at Paradi

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[*] First Report, vol. i. p. 17.

[†] Second Report, vol. i. p. 111.

[‡] First Report, vol. ii. p. 117.

ow, **Rotherhithe**, deep enough to suit the present levels, the first fect was, that it drained the wells; but after the sewer had been me time formed, and had received its accumulations, the water owed back into the wells, discoloured and polluted; and application as then made to the Commissioners for supplies of water, which used me to visit the spot, and by that means I learned the circumances. The sewer, by diluting the matter discharged into it, rendered more permeable, and saturated the substratum more extensively ith it. The inhabitants themselves ascribed the pollution to the backater from the sewers. Within a few days we have had an instance at attersea of the permeation of the cesspools in six new houses. They ere supplied with water from springs sunk to the same level as the sspools. As the springs were lowered by the consumption of the ater, it was found, to the surprise of the inhabitants, that instead of ming up clearer it was more discoloured, by the equalization of the ater levels. One of the inhabitants, a baker, who drew harder than e rest, applied to the Company to lay on the water, giving me to derstand that the people began to complain of the quality of his ead, the cause of which he could not make out, except it arose from e quality of the water, which, some how or other, was very bad. All s neighbours, who drew from the same spring, complained that the ater was very bad. The cause was, on examination, undoubted. ncient and celebrated springs are now being discontinued throughout e district; wells which were much frequented, are now gradually ing abandoned by the inhabitants; the pumps remain, and are used the poor who pass by, and who do not know their reputation; ople have imagined that it is the gas which has polluted the water, t it is the cesspools that are now being sunk so much lower than rmerly, partly that the water in the cesspools may not be higher than e level of the springs, and partly for the economy of cleansing. Inead of having a waggon-load of liquid refuse to remove, they have ow only a cart-load of the solid refuse to convey away."*

Promote physical and moral deterioration.

85. A nuisance which is thus proved to deteriorate property, to ison the air, to taint the food, and to pollute the water, ought not, on ese grounds alone, to be permitted; but there is a consideration conected with this subject which deserves the still more serious attention the statesman and the legislature, namely, the connexion which is

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* Evidence of Mr. Toynbee, First Report, vol. i. p. 80.

proved to exist between an habitual state of personal and domestic filt and the moral corruption of the people. “Nothing improves th habits so much,” says one of the witnesses,* “nothing civilizes a population so much as improvement in the modes of removing the excret of the population. I know scarcely any thing so demoralising an degrading as the common privies to various courts in towns, and t clusters of cottages in villages. For this reason, wherever I coul recommend it to be done, I have abolished them; and I conceive tha there should not only be separate accommodation for each house, bu where possible, separate accommodation for males and females of al classes.” “When the privies and receptacles for filth are neglected, says another witness,† “it is quite impossible for decent persons t continue the better habits they may have formed in other places: i tends to destroy everything approaching, I will not say to refinemen but to the common decencies of human creatures. A decent and respectable woman coming into such a district cannot maintain the cleanliness and propriety of demeanour to which she has been accustome A short time ago I was standing in one of the streets branching o from Rosemary Lane, called Blue Anchor Yard, looking at a stream o abomination that was flowing down from a court into the open gutter i the centre of this Blue Anchor Yard, the open gutter being the commo receptacle for the filth from the houses and privies. This noisom stream was flowing close to a house at the door of which there stood woman with ruddy cheeks, neatly clothed. ‘Five times this very da Sir,’ said she to me, ‘have I swept this place as clean as I possibl could; but you see the state in which it is again. It is no use to tr to keep it clean.’ Her whole appearance indicated that she was new comer; in a few days she would naturally give up her hopele attempt to keep the place clean, and if she remain there she mu necessarily sink into the state of squalor and filth so general among he neighbours.”

Abodes of the great criminals.

On the husband, the want of a decent and cleanly house is describe as still worse. “The wretched state of his home,” continues this witness,‡ “is one of the most powerful causes which induces a man t spend his money on strictly selfish gratifications: he comes home tire d exhausted; he wants quiet; he needs refreshment: filth, squalor, comfort in every shape are around him; he naturally gets away m it if he can."* "I have already more than once expressed my nviction," he adds,† "that the humanizing influence of habits of anliness and of those decent observances which imply self-respect, e best, indeed the only real foundation of respect for others, has ver been sufficiently acted on. A clean, fresh, and well-ordered use exercises over its inmates a moral, no less than a physical influ- ce, and has a direct tendency to make the members of the family ber, peaceable, and considerate of the feelings and happiness of each her; nor is it difficult to trace a connexion between habitual feelings this sort and the formation of habits of respect for property, for the ws in general, and even for those higher duties and obligations, the servance of which no laws can enforce: whereas a filthy, squalid, nwholesome dwelling, in which none of the decencies common to ciety even in the lowest stage of civilization are or can be observed, nds to make every dweller in such a hovel regardless of the feelings nd happiness of each other, selfish and sensual; and the connexion is bvious between the constant indulgence of appetites and passions of his class, and the formation of habits of idleness, dishonesty, de- auchery, and violence; in a word, the training to every kind and egree of brutality and ruffianism. This is what any man who has at ll turned his attention to the subject would expect; and a demon- tration of its truth appears to me to be afforded by the fact already tated, that in the worst districts of which we have been speaking, and n the most wretched of the hovels in these neglected districts, live, nd from birth have lived, that proportion of the population out of which come, not only the pickpockets, the thieves, and those other legraded and profligate persons who constitute the ordinary pests of ociety, but also in general our great criminals, violent and reckless nen, who every now and then perpetrate in cold blood, with a savage allousness, deeds which fill the whole country with disgust and iorror."

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* Evidence of W. C. Mylne, Esq., Civil Engineer, First Report, vol. ii. p. 10

† Evidence of Dr. Southwood Smith, First Report, vol. i. p. 14.

‡ First Report, vol. i. p. 15.

Water-closet apparatus cheaper than the Cesspool.

86. "At almost every step in the progress of this detailed inquiry," ay Her Majesty's Commissioners,‡ "it appears that the practical course

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* First Report, vol. i. p. 29.

† See also Evidence of Mr. Thomas Cubitt, First Report, vol. ii. p. 277.

‡ First Report, vol. i. p. 22.

of efficient improvement is not incompatible with the reduction c existing pecuniary charges, independent of the vast gain in the publ health, convenience, and comfort. Mr. Faden, architect, in his ev dence, affords examples of works in use, and gives instances in suppor of similar conclusions advanced by other practical witnesses, that unde appropriate arrangements water may be carried into houses, prope house-drains and means of cleansing introduced, and branch sewe formed at nearly one-half the annual or weekly expense now incurre for the proper cleansing of the cesspools alone."

It is also proved that a proper water-closet is far more economica than the cesspool; but in urging the introduction of water-closets fo the poorest dwellings, it is not intended to recommend the use of th apparatus now generally applied in superior houses, with its compli cations of cranks and wires, which are always getting out of order, an constantly leading to expense and trouble. There are various simpl means of applying water to this purpose, as shown in evidence by M Loudon, Mr. Foden, Mr. Smith of Deanston, and others; but th apparatus invented by Mr. Austin* appears to possess all the requisite for general adoption. It cannot be put out of order, and is self-acting It requires no cistern. It acts as a flushing apparatus each time b providing a great momentary rush of water, whereby the drains ar effectually cleared, and all effluvium removed. The total cost, includ ing fixing, is under forty shillings. Now, the removal of the nigh soil, from the cesspools of the poorer tenements in London, costs abou 1*l.* per annum, or 4½*d.* per week. Mr. Joseph Quick states † that h himself pays 1*l.* each for cleansing the smaller, and 3*l.* for cleansin the larger tenements; that judging from the experience of about ninet houses which he owns or manages, the cost is 3*d.* weekly; that the su would be larger but for the permeation of the fluid contents throug the surrounding soil, and that in some other places the cost is 5*d.* weekly. Now it is stated by Mr. Hawksley,‡ that a water compan would be glad to provide and maintain in constant and perfect use, a water-closet apparatus for the weekly charge of 1½*d.* per tenemen "My own observations and inquiry," adds this witness,§ "convinc me that the character and habits of a working family are more deressed and deteriorated by the defects of their habitations than by the reatest pecuniary privations to which they are subject. The most leanly and orderly female will invariably despond and relax her xertions under the influence of filth, damp, and stench, and at length ease to make further effort, probably sink into a dirty, noisy, discon-ented, and perhaps gin-drinking drab—the wife of a man who has no omfort in his house, the parent of children whose home is the street or he gaol. The moral and physical improvements certain to result from he introduction of water and water-closets into the houses of the orking classes, are far beyond the pecuniary advantages, however onsiderable these may, under certain circumstances, appear."

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* Manufactured by Dowson and Co., Welbeck Street.

† First Report, vol. ii. p. 122.

‡ First Report, vol. ii. p. 75.

§ First Report, vol. ii. p. 75.

Cesspool should be abolished.

87. These, and similar statements, have satisfied your Committee hat legislation on this point ought to be in accordance with the evidence, and with the recommendations of Her Majesty's Commissioners; that the construction of the cesspool in all new dwellings ought to be positively prohibited; and that the removal of all existing cesspools ought to be made compulsory, as soon as the general introduction of sewers and drains, combined with an ample suppy of water, shall have rendered the general introduction of the water-closet apparatus practicable.

Objectionable phrases in the Bill.

88. Your Committee, therefore, strongly object to the retention, in the proposed Bill, of words probably copied inadvertently from old precedents, which recognise the existence and extension of the cesspool and privy. Such, for example, as Clause 148, in which occur the following words:—"If such privy, drain, or cesspool shall be found to be made to the satisfaction of the said Commissioners." Again Clause 149:—"In case any cesspool, &c., shall on inspection be found not to have been according to the directions or regulations of the Commissioners." So also clauses 163 and 166, which authorise the retention of a most unwholesome and disgusting species of labour, and the extension and perpetuation of a degraded and reckless class of labourers.

It does appear to your Committee, that if intermittent supplies of unfiltered and filthy water, if expensive tanks and cisterns in which this water may stagnate and acquire still further impurities, if cesspools and privies, if "nightmen to carry away night-soil"—if all this is still to be perpetuated and encouraged, perpetuated and encouraged by being legalized, then indeed witnesses will have testified and commissioners will have reported in vain against a system which all classes concur in stating to be the most costly, and under which all declare that it is impossible that "any population can be healthy."

Ventilation.

89. The ultimate end of sewerage, drainage, and a supply of water adequate to the cleansing of sewers, drains, and streets, is to maintain the air, wherever human beings take up their abode, in a fit state for respiration. By a law of their nature men, and all warm-blooded animals, require for the maintenance of their existence that the whole mass of blood in their system should be constantly exposed to fresh currents of pure air. The chest and lungs, which constitute the apparatus for effecting this ventilation of the blood, occupy a large portion of the human frame; and so incessantly is this apparatus required to work night and day, during our waking and our sleeping hours, that were it to stop for the space of three minutes only, the result would be the irrevocable loss of life. By one action of respiration, namely, that of inspiration, pure air is carried into the system; by another action, that of expiration, impure air is carried out of the system, and a knowledge of what these actions really do is well calculated to impress upon the mind a sense of the value of ventilation.

Proportionate quantities of air and blood that react on each other at each act of inspiration.

90. When the function of respiration is performed calmly and in a natural manner, there are 18 respirations in one minute, and consequently 1080 in one hour, and 25,920 in 24 hours.* By each act of inspiration 1 pint of air is sent to the lungs, and consequently in one minute 18 pints, in one hour considerably more than two hogsheads, and in 24 hours upwards of 57 hogsheads. In the ordinary state of health there are 72 pulsations of the heart in one minute. By every pulsation of the heart there are sent to the lungs 2 ounces of blood, and consequently in one minute 146 ounces, being within 18 cubic inches exactly an imperial gallon; in one hour nearly 450 pints, or somewhat more than one hogshead; and in 24 hours nearly 11,000 pints, or upwards of 24 hogsheads. The blood performs one complete circuit in the system in 160 seconds, and consequently 540 circuits in 24 hours; so that there are three complete circulations of the blood throughout every part of the human body in every eight minutes of time.

91. In round numbers, then, there flow to the human lungs every minute, 18 pints of air and 8 pints of blood; and in the space of 24

* Philosophy of Health, by Southwood Smith, M.D., vol. ii. p. 83, § 429, *et seq.*

rs, 57 hogsheads of air and 24 hogsheads of blood; and these cur- its, in the same relative proportions, continue to flow towards each er unceasingly night and day from the moment of birth to that of th. By arrangements and adjustments of matchless beauty this ss of blood is brought in the lungs into contact with this immense ume of air; into contact sufficiently direct and close to expose to s air every particle of blood in such a manner as completely to ate it; and the object of all this delicate and complex structure, l of its wonderful action, is to effect this ventilation of the blood.

92. By the constitution of our frame, then, a constant supply of sh air is a necessity of our nature which we cannot disregard with- t incurring that penalty of suffering which is affixed to the violation neglect of every law of nature.

Poisons diffused in the atmosphere are carried by the inspired air directly into the blood.

93. Wherever animal and vegetable substances are undergoing the ocess of decomposition, poisonous matters are evolved which, mixing th the air, corrupt it, and render it injurious to health and fatal to e. But wherever human beings live together in communities, these rge masses of animal and vegetable substances, the refuse of food and other matters essential to human existence, must necessarily be ways decomposing. If provision is not made for the immediate re- oval of these poisons, they are carried by the air inspired to the air- lls of the lungs, the thin delicate membrane of which they pierce,* nd thus pass directly into the current of the circulation. It has been own that by the natural and ordinary flow of this current, three dis- nct and fresh portions of these poisons must necessarily be transmitted every nook and corner of the system in every eight minutes of time. he consequences are sometimes death within the space of a few ours, or even minutes; at other times a progressive and rapid, or a rogressive but slow deterioration and corruption of the whole mass of he blood; a consequent disorganisation of the solid structures of the ody, and the excitement of those violent commotions of the system hich constitute fevers, choleras, dysenteries, and other mortal pidemics.

Pure air necessary within dwelling-houses as well as externally.

94. Supposing, however, that sufficient wisdom and energy were lirected to this subject (though this is a supposition which has never et been realized in a single instance), to remove these poisons as soon s generated from towns and cities, so as to maintain the external at-

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* Philosophy of Health, vol. ii, p. 43, § 366, *et seq.*

mosphere of populous districts in a state of tolerable purity, the grea majority of human beings pass only an inconsiderable portion of thei time in the open air. Two-thirds at least of the twenty-four hour are spent in-doors—in the sitting-room, the work-room, or the bed room; and consequently life and health must necessarily depend o the quantity and quality of the air *within* the house. Yet in house as at present constructed, the air in the rooms is pent up closely withi four walls, without the possibility of the entrance of a single particl of fresh air (the windows being closed), except what can force its wa through the crevices of the window and door, and without any mean of escape for the vitiated air except that afforded by the chimney. Universally, up to the present time, the main object contemplated i the construction of houses has been to render them the means o affording protection from cold and wet. To fit them for the habitation of air-breathing creatures, who cannot preserve their existence three minutes without air, nor their health a single hour without fresh air, has been so little thought of, that at the present moment there is not one house in ten thousand, perhaps not one in a hundred thousand, provided with well-devised and successful means of affording day and night a free ingress of pure air, and a free egress of vitiated air. Nevertheless, the vitiation of the air in a room in which a person is breathing, and which is unprovided with such means, is progressive. When the air, which has been once respired, and which has thereby become vitiated, is projected in a room from the mouth and nostrils,* it first moves in a horizontal direction, and then slightly downwards, when it immediately begins to ascend. In experiments made on this subject, by placing different individuals in a box lined with cotton, open above and below, and suspended midway in the air, a current of air is observed constantly to ascend on every side from the person, and the temperature of the air is found to be in general four degrees higher above the head than below the feet. In unventilated apartments this movement of an ascending current is always accompanied by a proportionate descent of respired air that had made its way towards the ceiling. With every new respiration another portion of vitiated air ascends, and displaces a proportionate current of vitiated air which descends, and so the currents go on continually ascending and descending from the ceiling to the floor, until at last the person is ompletely enveloped in a mass of corrupted air, which he vitiates more nd more with every breath he takes. This process of vitiation in-reases with the number of persons in the room, with the kind of usiness carried on in it, with the number of candles, lamps, and gas-ghts, the vitiation being in general in proportion to the intensity of e illumination.

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* Second Report, vol. ii. p. 38

Effect of living without a supply of fresh air.

95. To live in rooms under circumstances such as these is really to ve without our breathing apparatus; and the effect is practically the ame as if a large portion of the air-cells of the lungs were positively bliterated; as if the function of respiration were reduced to the mallest possible quantity short of stopping it altogether; or, what is ust the same, as if a cord were fastened round the neck so as nearly to lose the opening of the windpipe.

Respiration the main source of vital energy.

96. It is matter of familiar knowledge that the function of respira-ion is the main source of vital energy; that in the entire scale of the nimal creation, creatures are active and powerful in proportion to the xtent of their respiration; that the chief difference between the cold-looded animal, the reptile—as the frog, and the warm-blooded animal —as the bird, is the difference in the extent of their respiratory appa-atus, and the consequent difference in the quantity of air that ventilates heir blood; that in the various tribes of warm-blooded animals, acti-ity and power are invariably in strict relation to the energy of their respiration; that is, to the proportionate volume of air that acts upon their blood, and that this is the main physiological difference on which depends the constitutional difference between the hare and the tiger, the sheep and the lion. The same law is observable even in different individuals of the same species, and especially among different individuals of the human race. In man, as has been shown, the apparatus of respiration is of great extent, and invariably those individuals who possess the greatest degree of physical energy and power, are those in whom the respiratory apparatus is the most developed, as indicated by their broad expanded chests. What, then, must be the effect upon human beings, of the privation of this life-giving function—of living under circumstances which render useless to them their chest and lungs! What must be the effect upon the health and strength of creatures intended by nature to consume, every twenty-four hours, fifty-seven hogsheads of pure air, that never, from morning to night and from night to morning, obtain a single pint of it!

Diseases produced by imperfect supply of fresh air.

97. We know from melancholy experience what the effect is—a feeble and puny population, unable to work, and incapable of enjoyment; unfit equally for the duties and the pleasures of life; a diseased population; for the very same circumstances that deprive these classes of a due supply of fresh air, positively corrupt what air they have, and oblige them unceasingly to breathe a poisoned air; the inevitable consequence being a poisoned blood and a tainted constitution; that is, a constitution tainted with scrofula, and prone to consumption.

Scrofula.

98. The following (and many more might be cited) are attestations of this melancholy truth, by high medical authority.

"The constant respiration of the same air in their ill-ventilated apartments is the main cause of the scrofulous taint which to such an enormous extent corrupts and enfeebles the constitution of the poorer classes and that of their offspring. If the air respired be entirely pure, there may be bad food, bad clothing, and want of personal cleanliness, but scrofulous diseases are not developed." [*]

"The impure air of workshops, and the similarly unwholesome state of the dwellings of the poor, are the chief causes of the scrofulous diseases to which they and their children are so subject." [†]

"Deficiency of fresh air is among the most powerful and the most important, because the most remediable, of the causes from which scrofula arises." [‡]

"The habitual respiration of the same air in ill-ventilated workshops in large towns is a powerful means of augmenting the hereditary disposition to scrofula, and even of inducing such a disposition *de novo*." [§]

Consumption.

99. The evidence is equally decisive as to the influence of the same cause in predisposing to consumption, and in actively developing this dreadful malady. "If," says Sir James Clark, [‖] "an infant born in perfect health and of the healthiest parents be kept in close rooms in which free ventilation is neglected, a few months will suffice to induce tuberculous cachexia; that is, the constitutional affection which invariably precedes the appearance of consumption." It is found by direct experiment on animals that consumption may be induced in them to any extent merely by confining them to close and dirty rooms. "In

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[*] Evidence of Mr. Toynbee, First Report, vol. i. p. 69.

[†] Evidence of Dr. Guy, First Report, vol. i. p. 98.

[‡] Evidence of Professor Alison, First Report, vol. i. p. 73.

[§] Evidence of Sir James Clark, First Report, vol. i. p. 74.

[‖] Ibid.

the Zoological Gardens in the Regent's Park," says Dr. Arnott,* a new house was built to receive the monkeys, and no expense was spared which, in the opinion of those intrusted with the management, could ensure to these natives of a warmer climate all attainable comfort and safety. Unhappily, however, it was believed that the objects would be best secured by making the new room nearly what an English gentleman's drawing-room is. For warming it, two ordinary drawing-room grates were put in, as close to the floor as possible, and with low chimney-openings, that the heated air in the room should not escape by the chimney, while the windows and other openings in the walls above were made as close as possible. Some additional warm air was admitted through openings in the floor from around hot water pipes placed beneath it. For ventilation in cold weather, openings were made in the skirting of the room close to the floor, with the erroneous idea that the carbonic acid produced in the respiration of the animals, because heavier than the other air in the room, would separate from this, and escape below. When all this was done, about sixty healthy monkeys, many of which had already borne several winters in England, were put into the room. A month afterwards more than fifty of these were dead, and the few remaining ones were dying. This room, open only below, was as truly an extinguisher to the living monkeys as an inverted coffee-cup, held over and around the flame of a candle, is an extinguisher to the candle. Not only the warmth from the fires, and the warm air that was allowed to enter by the openings in the floor, but the hot breath and all the impure exhalations from the bodies of the monkeys, ascended, first, to the upper part of the room, to be completely incorporated with the atmosphere there, and by no possibility could escape, except as a part of that impure atmosphere, gradually passing away by the chimney and the openings in the skirting. Therefore, from the time the monkeys went into the room until they died, they could not have had a single breath of fresh air. It was necessary only to open, in the winter, part of the ventilating apertures near the ceiling, which had been prepared for the summer, and the room became at once salubrious.

"The day after I saw the monkey-house just mentioned, I was sent for to visit a young gentleman at a respectable school in the neighbourhood of London, where there were about forty boys. The boy I went to see was thought to be falling into consumption, and I learned that others of the boys also were ill. On examination, I found the cause to be only a less degree of the error which had destroyed the monkeys. The two cases struck me forcibly, as illustrations of the little knowledge on the important subject of the essentials to health possessed by persons otherwise highly accomplished. A new school-room had been built at the back of the dwelling-house, in which room the forty boys spent much of their time, and there was no opening by which their breath could escape from the room except through the low fire-place. There was indeed a skylight above with sashes, which might be opened; but the schoolmaster told me that he took care never to open these when the boys were present, because, having done it once, a boy got severe inflamation of the lungs in consequence of the cold air rushing in upon him. This gentleman had gone to great expense to secure, as he thought, the health and comfort of his scholars; but, from want of knowledge on the subject, had missed his aim, just as had happened in the case of the monkey-house."

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* First Report, vol. i. p. 52.

Number of deaths from consumption.

100. The number of deaths from consumption occurring every year in England and Wales, according to the return of the Registrar-General, amounts to nearly 60,000. From a careful analysis and examination made by Dr. Guy,[*] it appears that the proportion of the consumptive cases of the three classes of the people—gentlemen, tradesmen, and labouring men—are respectively as 16, 33, and 30; that consequently, tradesmen are nearly twice as liable to consumption as the gentry, owing chiefly to the hot, close, ill-ventilated shops in which the former pass so many hours of the day; that in-door labourers are more subject to consumption than those who follow their employments out of doors, though exposed to all the inclemencies of the weather, and though in-door labourers as a class earn higher wages, and can therefore command better food, clothing, and lodging; and that of in-door labourers, those engaged in workshops are more subject to consumption than those employed at home, because the air of the poor men's apartment, small and mean as it is, is more wholesome than the greater portion of workshops or even of shops. "A certain amount of consumption,"[†] continues this witness, "probably about one in seven of all deaths above fifteen years of age, which is nearly the proportion occurring in the higher orders and in the most healthy professions, may be considered as inevitable, but all beyond that proportion admits of

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[*] First Report, vol. i. p. 93, *et seq.*

[†] First Report, vol. i. p. 102.

revention. The annual waste of life from pulmonary consumption
lone may be safely stated at upwards of 5000, and this estimate is pro-
bly much below the truth. The chief cause of this great mortality
the defective ventilation of houses, shops, and places of work."

101. It cannot but be useful to the legislature to bear such facts as
ese in mind while devising a large and practical sanatory measure,
d your Committee regard it as a great defect in Lord Lincoln's Bill,
at it omits altogether the subject of ventilation, resembling in this
spect those modern encyclopædias of architecture and building in
hich the very word ventilation never once occurs from beginning to
d.* The general introduction of an efficient mode of ventilation in
welling-houses and especially in the abodes of the poor, would be
ttended with beneficial results far beyond what it is possible to esti-
ate; still, however, the adoption of compulsory provisions for this
urpose may not be expedient, on account of the interference with the
rivacy of domestic life which the enforcement of any such legislative
nactments must involve. But this objection does not apply to build-
gs intended for public resort, such as churches, courts of justice,
oncert and assembly-rooms, theatres, houses and rooms for the public
se of which a licence is required; factories already under government
egulation and inspection; workshops in which great numbers of work-
eople habitually assemble, lodging-houses, and schools. The intro-
luction in a general sanatory measure, of complsory provisions for the
urpose of securing proper ventilation in all places of this description,
ppears to be justified by the absolute necessity of the case, and to be
ree from any objection in principle. And thus far Her Majesty's
ommissioners sanction the principle of compulsory ventilation, one of
heir recommendations† being, "that measures be adopted for 'pro-
noting a proper system of ventilation in all edifices for public assem-
blage and resort, especially those for the education of youth."

Bill omits all notice of ventilation.

Compulsory ventilation.

They further recommend ‡ the regulation of lodging-houses, and the
ompulsory cleansing of any house or premises which is in such a filthy
nd unwholesome state as to endanger the health of the public, or in which
ny infectious disorder is known to exist.§ The proposed Bill (clause
177) adopts the recommendation of Her Majesty's Commissioners as to
the compulsory purification of filthy and infected houses, and also the

Lodging-houses. Compulsory cleansing of private houses.

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[*] First Report, vol. i. p. 54.

[†] Second Report, vol. i. p. 119.

[‡] Second Report, vol. i. p. 122.

[§] Ibid. p. 120.

Power to remove houses that prevent currents of air through streets.

Thoroughfares.

Public walks.

recommendation (clause 170) as to the inspection and regulation of lodging-houses. It is submitted that power should also be granted to the local administrative body, under the direction of the inspector and the district officer of health, to remove any house or houses which are so situated as to render a street a cul-de-sac, preventing the possibility of a current of air from passing through it, and likewise to raise money for opening thoroughfares, and for the construction and maintenance of public walks.*

Nuisances.

102. One great source of the contamination of the atmosphere in towns, and of the deterioration of the physical condition of the population, arises from certain nuisances, such as collections of dung, nightmen's yards, pigsties, cow-yards, slaughter-houses, and manufactories giving out offensive and noxious emanations.

Summary powers for the abatement of nuisances.

103. Much detailed evidence is collected to show the extent to which these nuisances prevail, and the amount of injury and suffering they inflict. After a careful consideration of this whole subject, Her Majesty's Commissioners arrive at the following conclusions: † namely, that with regard to the most common of these nuisances, they might be materially abated, if not totally suppressed, by the active exercise of summary powers; that therefore these nuisances should be declared nuisances, and be summarily abated; that in this way, for example, the innumerable evils arising from the filthy state of privies, might be prevented in all places where they are exposed to public view; that with regard to some other nuisances, they should be declared to be absolutely illegal, and be positively forbidden—such as keeping pigs in towns; accumulations of filth in nightmen's yards, and collections of dung for sale; that all slaughter-houses should be placed under inspection and regulation; and that in cases where the inhabitants are injuriously affected by the noxious exhalations of any factory, power should be given to the local administrative body to take legal proceedings for the abatement of the evil;‡ and that "as the most constant attention is required for the punctual enforcement of any laws or regulations, an officer be appointed in each town, who, in addition to other duties that may be placed under his charge, should be required to report upon any neglect on the part of the scavengers, or any infringement of rules for

Appointment of Inspector of Nuisances recommended.

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* See the Thirtieth Recommendation of Her Majesty's Commissioners, Second Report, vol. i. p. 122, *et seq.*

† Second Report, vol. i. p. 76, *et seq.*

‡ Ibid. p. 83.

e prevention of nuisances, or of any other matter affecting the health
the inhabitants; and, if necessary, to commence proceedings in his
n name, and as an informer on the part of the public, for the punish-
ent of offenders before the magistrates. "Such an officer," continues
e Commissioners,* "would receive much valuable assistance in the
ecution of his duties, and the public would be checked in their in-
ingement of the law, if the police were directed to report upon any
each or neglect of it. These public servants, now generally a nume-
us and efficient body in each large town, although the constant wit-
sses of such offences, are not charged with the duty of reporting them
their superiors, or any officer empowered to correct them. It has
en represented to us that this duty could be most efficiently and con-
niently executed by the police without any serious addition to their
hours, or increase of expense to the inhabitants."

Assisted by police.

Bill appoints Inspector of Nuisances.

104. In accordance with the spirit of these recommendations, the
ill (clause 178 *et seq.*) proposes the appointment of an Inspector of
uisances, defining his duties, and arming him with the necessary
wers; and authorizes the Commissioners from time to time to make
ye-laws as they shall think fit for the purposes following; (that is
say):—

For preventing nuisances and annoyances in any streets, or near
ereto, and effecting cleanliness therein.

For making regulations for registering and inspection of slaughter-
ouses and knackers' yards, and for keeping the same in a cleanly
nd proper state, and for removing filth therefrom, at least *once* in
very *twenty-four* hours, and for requiring that they shall be provided
ith a sufficient supply of water.

For regulating the manner of keeping swine, and preventing the
eeping thereof within any dwelling-house; and for describing the
imits in such town or district within which it shall be lawful to keep
he same.

For the punishment of persons selling unwholesome meat, and for
izing and condemning the same.

For regulating the duties of scavengers, and the management of
ublic privies.

For making regulations for the registering of lodging-houses, and for maintaining cleanliness therein, and keeping them in a wholeso condition.

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* Second Report, vol. i. p. 79.

For laying down rules for cleansing filthy and unwholes dwellings.

And to ascertain and fix what pecuniary penalties shall be incurre by persons breaking such laws.

Nuisances from manufactories omitted by the Bill.

105. No means, however, are proposed by the Bill for the suppressi or mitigation of the grievous nuisances arising from manufactories whi emit offensive and noxious emanations, and which are often situated i the closest and most densely populated districts. Yet so strong is th conviction of Her Majesty's Commissioners, from the investigations an reports of the Commissioners themselves, as to the extent to whic nauseous, acrid, and other noxious fumes from manufactories destro the atmosphere, not only in numerous dwellings, but sometimes i whole streets, as to the injury they produce to health, independentl of their effect upon property, and as to the difficulty of exercising a control over them in the present state of the law, that they say, "W have been induced to submit a recommendation for the prevention o these sources of injury, under the conviction that great evils do ari from factories, that may influence at times a whole population, whi the difficulties that attend the demonstration of the first one often s great that it is permitted to continue for years without any pers being willing to undertake the expense of proving the case. Th adoption, however, of the course now indicated, will enable such di ficulties to be overcome; and there appears to be no good reason, if private dwelling be made subject to inspection, under circumstanc affecting, or supposed to affect, the public health, why manufactori which induce such evils to a much greater extent, should not be subje to the general cognizance of the local administrative body who shou be empowered in certain cases to take the necessary legal proceedin for the abatement of such nuisances. The Commissioners add:*—

"Too much importance has hitherto been attached to the mere influence of lofty chimneys in removing to a distance, and dilating th noxious fumes which many manufactories evolve. In themselves the in no way destroy the emanations which are conveyed into them: thes are discharged as much as before into the external atmosphere, and experience has proved, that even very lofty chimneys, on which larg ms have been expended, do not necessarily insure that amount of mixture with the common air which is essential to prevent the most urious consequences on their deposition even at very considerable tances."

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* Second Report, vol. i. p. 82.

Chemistry, however, by the very power with which it advances the ts and manufactures, supplies the means of controlling and destroying injurious products arising from chemical operations. On this ound, Her Majesty's Commissioners recommend[*] "that in cases ere complaints shall be substantiated, that the inhabitants of any se, street, or district in towns, are injuriously affected by the noxious halations of any factory, power be given to the local administrative dy to ascertain the cause of such exhalations, and to take legal proedings for the abatement of the evils, in the event of such evils not ing removed on due representation."

Onus should be fixed on owners of factories.

106. It is submitted, that the law should fix on the owners of facries the *onus* of proving that they habitually and carefully put into actice, in their works, the best means known of controlling and stroying the noxious products to which their processes give rise, and at in cases in which it is impracticable in the present state of knowlge either to neutralize or to prevent the evolution of these noxious oducts, the continuance of the operations that produce them, in the idst of populous districts, should be absolutely forbidden. Mr. homas Cubitt[†] has given valuable and decisive evidence as to the ry slight degree of individual hardship that would practically result om such a prohibition under the operation of a general law.

Smoke nuisance.

107. One nuisance not noticed by the Bill, but the subject of a stinct recommendation by Her Majesty's Commissioners, is that arising om the dense black smoke of manufactories. "Next to the evils ising from defective draining and cleansing," state Her Majesty's ommissioners,[‡] "none are so offensive or produce so large an amount f discomfort to the inhabitants of towns generally, as those arising om this dense black smoke."

Instructions of Lord Lincoln.

108. It is stated by Lord Lincoln,[§] that private Bills for the exress purpose of suppressing this nuisance have been introduced into

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[*] Second Report, vol. i. p. 83.

[†] First Report, vol. ii. pp. 277, 278 *et seq.*

[‡] Second Report, vol. i. p. 81.

[§] Instructions to Sir Henry T. de la Beche and Dr. Lyon Playfair, Smoke rohibition Inquiry, p. 1.

Parliament, and in some instances become law; that a desire has be
very generally expressed in Parliament that the principle of th
Bills should be extended to every part of the kingdom; that inquir
having reference to this subject have been instituted by Select C
mittees of the House of Commons, particularly one in 1844 a
another in 1845; that in 1845 a Bill providing for the general su
pression of smoke was withdrawn upon an understanding that a subj
of such admitted public importance should be left in the hands of H
Majesty's Government, and that some general measure having for
object the suppression of smoke in towns and populous districts shou
be by them submitted to Parliament. But his Lordship further stat
that before any pledge of this nature can be satisfactorily fulfilled, H
Majesty's Government are of opinion that there is still matter for fu
ther investigation, and appoint Sir Henry T. de la Beche and Dr. Lyo
Playfair to renew the inquiry.

Smoke Prohibition Report.

109. These gentlemen report[*] that they are unable to add anythin
to the information contained in the Reports of the Select Committe
of 1843 or 1845, as to the nuisance of smoke, as to the nature of t
patents taken out, and of the processes in use for its consumption, a
as to the expediency of adopting legislative enactments for its preve
tion in all practical cases; that the prevention of smoke is a thi
perfectly practicable; that the mode of accomplishing this object
well understood; that as the prevention of smoke implies a compl
combustion of fuel, the result as an abstract fact always is, that m
heat is generated and a saving of fuel effected when it is so consum
as to prevent the emission of smoke; and that from experiments c
ducted under their investigation with a view to determine this poin
their own satisfaction, they arrive at the conclusion, that although fr
careless management of fires there is often no saving, and that ind
there is frequently a loss of heat, still that with careful managem
the prevention of smoke is in many cases attended with, and might
most cases be made to produce, an economy of fuel.

Causes of smoke.

110. With regard to the cause of the emission of smoke in ma
factories, they report that it is owing either to the bad constructio
fire-places, boilers, and flues, or the bad management of the pers
intrusted with the fires.

Causes of failure of Acts.

111. With regard to the causes of the general failure of the L

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[*] Smoke Prohibition Report, addressed to Viscount Canning, p. 2 *et seq.*

ts to suppress the nuisance, they state that it is sometimes owing to leniency, sometimes to the severity of the enactments, at other es to the expense of enforcing their observance, and above all, to looseness with which the clauses have been drawn up. It appears t most of the recent Acts for the Prohibition of Smoke are founded the clause in the Derby Improvement Act, which enjoins a penalty or or in respect of every week during which such furnace or annoyce shall be so used or continued." Now, as it cannot be proved t smoke does continue without cessation for a "whole" week, seeing t, in all chimneys, there are periods when no smoke is emitted, and t smoky chimneys do not emit opaque smoke more than twenty, and the worst cases not more than thirty minutes in the hour, and that night the small amount of fire kept on in the furnaces prevents the ission of smoke, no conviction can be obtained under this Act. minent legal authorities have been consulted, and have stated as their inion, that for the purposes of conviction it is essential to prove at a furnace continues to smoke for a whole week, without interrupon. As the wording of most of the other Acts has been copied from is, they have proved in practice to be wholly inoperative.

Loose wording of Acts.

112. Another point in the wording of the Acts which renders them actically useless, consists in the penalty, generally of 40*s*., not being vied until after "one month's notice in writing" shall have been iven to discontinue the emission of the smoke. Hence, after the ffending party has been brought before the magistrate, and convicted the penalty of 40*s*., it is necessary, previous to the infliction of a econd penalty, again to give "one month's notice in writing," so hat, in fact, a month being also allowed to abate the nuisance, if the w were proceeded with, only six fines, amounting in the whole to 2*l*., could be obtained in the course of the year; a sum so small, that refractory smoke-maker would be willing to pay it rather than be ut to the greater expense of altering his boilers or furnaces. The mallness of the fines acts prejudicially to the success of the Acts in erby, Leeds, Manchester, &c., just as their magnitude has a similar ffect in Birmingham, by preventing the authorities from duly proceedng to recover penalties, each penalty being 50*l*. instead of 40*s*. Still he recovery of one penalty last year had the good effect of inducing eventy or eighty works throughout the town to adopt contrivances for he prevention of smoke.

Leniency or severity of penalties.

Want of superintendence.

113. A third cause of the failure of recent Acts is the want provision for appointing inspectors with sufficient powers to enfo an observance of the enactments. The Acts give to the lo magistrates the decision respecting all alleged infringements of t law; but these magistrates themselves are frequently the pri cipal smoke-makers, and cannot, therefore, be expected to be ve zealous in the execution of the law. In every instance in which th authorities have instituted proceedings under the Act, the consequen has been a considerable abatement of the nuisance; but after the lap of a certain period, it has again appeared with its usual intensi Thus Mr. Beckett, member for Leeds, when examined before th Committee in 1843, stated that the smoke clause in the Leeds Im provement Act of 1842 had already been productive of benefici effect, and that the nuisance was considerably abated; "but," say th reporters,[*] "when we visited that town in the present year, the chim neys were pouring out black and opaque smoke, as if no Act prohibitin it existed. A smoke-inspector had been appointed, but latterly ha from illness, been most inefficient; and the authorities, more from kindly than politic feeling, had been unwilling to appoint an efficie man in his stead. A month or two passed away after his deat without a successor being appointed, and the manufacturers, seein that no one looked after the nuisance, became careless, and poure forth opaque smoke as before. At last, two more inspectors we appointed; but this duty was made incidental to other duties, one o them being the superintendent of scavengers, the other of the tow lamps; and it still remains to be shown whether the town of Leed will return to its state of improvement."

The experience of Bradford[†] is similar to that of Leeds. Several years since, the inhabitants congratulated themselves on the grea diminution of the smoke-nuisance in that town; but recently the evil ha again sprung up as severely as before. The smoke clause in the Ac of this town contains no provision for adequate superintendence. appoints no controlling power to see that the Act is carried into execution, and hence the evils have again appeared.

In Manchester[‡] the Act has been brought so recently into force, that it is impossible to predicate either its success or failure; but the town-clerk, Mr. Heron, states that the same legal difficulties are perienced in this town also, and that were it not for the good eling and co-operation of the manufacturers, the clause would be actically inoperative.'

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[*] Smoke Prohibition Report, p. 4.
[†] Ibid. p. 5.
[‡] Ibid.

Want of power to inflict penalty on stoker.

114. A fourth cause of failure is a want of power to inflict a nalty on the stoker, whose carelessness is very often the entire cause the evil. "In all the towns referred to,"* say the reporters, complaints were made of the absence of power to inflict a fine upon e stoker for carelessness in managing any smoke-consuming aparatus, even in stoking ordinary fires. Upon this point the opinion is iversally expressed, that all Acts will be inoperative unless the oker also, as well as the master, be made an interested party in seeing the due execution of the Act.

The reporters further state,† that with regard to steam-engines e processes for the prevention of smoke have been matured; that ose processes have, in very many instances, been employed with mplete success; that a law suppressing the nuisance from these urces could, therefore, be most easily and promptly carried out; d that the same is true with regard to breweries, distilleries, dye-orks, &c., there being certain instances in which processes for the revention of smoke have with them proved successful, whence "it ay be anticipated that the nuisance arising from these sources also ay be much abated, if they be subjected to the general law with that rbearance and caution which, under certain cases, is so advisable."

Smoke Prohibition Bill of last Session (1846).

115. On these grounds, that the emission of smoke from the consumption of fuel is not necessary, that there are known means by which can be entirely prevented, and that, therefore, a law prohibiting he continuance of the nuisance is capable of being carried into effect, nother Bill ‡ "to prohibit the Nuisance of Smoke from Furnaces r Manufactories," was introduced into Parliament during the last ession (1846), containing, among others, provisions for the appointment of an Inspector of Smoke Nuisance, prohibiting "the issue of paque smoke from any chimney of a furnace for any longer period f time than is *bonâ fide* necessary for the kindling of the fire of such furnace;" fixing on the occupier of such a furnace, for every offence gainst this Act, the penalty of "any sum not exceeding five pounds,"

Provisions.

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[*] Smoke Prohibition Report, p. 5.

[†] Ibid. p. 6.

[‡] Prepared and brought in by Mr. Mackinnon, Lord Francis Egerton, and Mr. William Beckett. Ordered by the House of Commons to be printed, June 8, 1846.

rendering it sufficient proof of offence against the Act, 'that smoke has been seen to issue from the chimney in question' for a longer time than is limited by the Act;" and empowering the owner to recover a part or the whole of the penalty and costs that may have been awarded against him, and which he has paid, "from any other person through whose negligence or wilful misconduct" the offence has been committed.

Omissions.

116. This Bill is, therefore, free from the main errors and defects which have rendered nugatory preceding Acts; but still the Bill, as at present framed, gives no powers to the inspector. It makes no provision for rendering the reception of his evidence obligatory on the magistrate; it restricts unnecessarily the meaning of the word "furnace," to "such furnaces only as are used for the heating of stationary steam-engine boilers;" while it is certain that "by judicious and careful stoking, by the adoption of special arrangements, or by the use of smokeless fuel,"* the prevention of smoke from locomotive steam-engine boilers is as practicable as from those that are stationary, it being further distinctly stated by Her Majesty's Commissioners,† that "the use of any but smokeless fuel is forbidden on many railroads, and it would be a great improvement if this was extended to steam-boats navigating rivers." It limits the utmost penalty of any offence against the Act to the sum of five pounds; and thereby, considering the magnitude of many of the manufactories that pour out the most constantly the densest columns of black smoke, and the wealth of their owners, it endangers the successful working of the Act by reason of leniency (see above, § 111); and it omits the recommendation,‡ founded on large experience, that simple forms of notices and penalties should be attached to any general Act.

Pledges of Government.

117. This Bill, like the two other Bills noticed by Lord Lincoln, was at the close of the Session withdrawn, on an intimation given by Lord Morpeth that, if left in their hands, Her Majesty's Government would take up the subject; so that the present administration, as well as the last, is pledged to "the introduction to Parliament of some general measure, having for its object the suppression of smoke in towns and populous districts;" and it is submitted that the means of framing a practical and efficient measure are now clearly made out for them.

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* Second Report, vol. i. p. 81. † Ibid.

‡ Smoke Prohibition Report, p. 5. Evidence of Mr. Ikin, town-clerk of Leeds.

Medical Officer of Health.

118. Her Majesty's Commissioners state,* that "the most eminent medical witnesses concur in declaring that it is by the careful observation of the causes of disease and mortality operating upon large classes of the community, that the mode and extent of their operation may be ascertained, and the power of diminishing and preventing them be acquired; that for this purpose the appointment of an officer, whose duty it would be to direct his undivided attention to such causes, would, in our opinion, be a public benefit, more especially to the poorer classes, and might be advantageously employed in making investigations into matters affecting the sanatory condition of the district under his charge." In accordance with this view they add:—"We therefore recommend that the local administrative body have power to appoint, subject to the approval of the crown, a medical officer properly qualified to inspect and report periodically upon the sanatory condition of the town or district, to ascertain the true causes of disease and death, more especially of epidemics, increasing the rates of mortality, and the circumstances which originate and maintain such diseases, and injuriously affect the public health of such town or populous district."

Provisions of the Bill relative to Officer of Health.

119. The Bill adopts this recommendation and proposes the following enactments:†

"And whereas the health of the population, especially of the poorer classes, is frequently injured by the prevalence of epidemical and other disorders, and the virulence and extent of such disorders are frequently due and owing to the existence of local causes which are capable of removal, but which have hitherto frequently escaped detection from the want of some experienced person to examine into and report upon them, it is expedient that power should be given to appoint a duly qualified medical practitioner for that purpose: Be it therefore enacted, that it shall be lawful for the said Commissioners to appoint, subject to the approval of one of Her Majesty's Principal Secretaries of State, a legally-qualified medical practitioner, of skill and experience, to inspect and report periodically on the sanatory condition of any town or district; to ascertain the existence of diseases, more especially epidemics, increasing the rates of mortality; and to point out the existence of any nuisances or other local causes which are likely to originate and maintain such diseases and injuriously affect the health of the inhabitants of such town or district; and to take cognizance of the fact of the existence of any contagious disease, and to point out the most efficacious mode for checking or preventing the spread of such diseases; and also to point out the most efficient means for the ventilation of churches, chapels, schools, registered lodging-houses and other public edifices within the said town or district, and to perform any other duties of a like nature which may be required of him; and such person shall be called the Medical Officer of Health for the town or district for which he shall be appointed; and it shall be lawful for the said Commissioners to pay to such officer such salary as shall be approved of by one of Her Majesty's Principal Secretaries of State."

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* Second Report, vol. i. p. 122.

† Clauses 175, 176.

120. "And be it Enacted, That whenever it shall be lawful for any coroner to summon medical witnesses and to direct the performance of a post-mortem examination, under the provisions of an Act passed in the Session of Parliament held in the sixth and seventh year of the reign of his late Majesty King WILLIAM the Fourth, intituled, 'An Act to provide for the Attendance and Remuneration of Medical Witnesses at Coroner's Inquests,' it shall be lawful for such coroner to issue his order for the attendance of the medical officer of health for the town or district within which any such inquest shall be held, and to direct the performance by such medical officer of a post-mortem examination, with or without analysis of the contents of the stomach or intestines, without fee or reward; and any provisions contained in the said Act for imposing any penalty on any medical practitioner for any disobedience of any order of such coroner shall be taken to extend and apply to such officer of health."

Primary duties of Officer of Health.

121. The duties assigned to the medical officer of health in the first of these clauses are highly important, and the able performance of them throughout the country will produce beneficial results, the true value of which it is impossible at present to estimate. Still, however, these provisions do not go to the root of the matter, nor embrace the primary and fundamental duties of the officer of health. These fundamental duties are the verification of the fact as well as of the cause of death, the correct registration of both, and the personal examination on the spot of the sanatory circumstances under which death takes place. It is only by the performance of these primary duties that the duties described in the Bill can be properly performed; that the existence and prevalence of diseases can become known; that the local causes originating and maintaining such diseases can be traced; that the most

efficacious modes of checking or preventing their spread can be ascertained; and, consequently, that a true report on the sanatory condition of any town or district can be framed.

Verification of the fact of death.

122. There are purposes to be answered by making it compulsory on the officer of health to verify in every case, by inquiries made upon the spot, the fact of death, of far greater importance than are apparent at first view. In the performance of this duty the medical officer, chosen, let us suppose, from the highest rank of his profession, and selected on account of his practical knowledge and his eminence in science, must necessarily visit, whenever a death takes place, the hovels of the lowest persons in the realm. Such a visit would be attended with inestimable benefit both to the individual families in particular and to the community in general. It is indeed quite impossible that the public should at present have any appreciation of the value of this kind of service, because none but those who are in the habit of visiting those dreadful abodes have, or can have, the slightest knowledge of the manner in which the event of death adds to their wretchedness and increases their danger. But the veil which concealed from the general eye the state of the masses that compose the lowest portion of the base of the great pyramid of society has at length been lifted up, and all whose duty it is to make themselves acquainted with this state are now without excuse if they do not understand it. It is true indeed that the descriptions given by witnesses whose duties require them constantly to visit these wretched abodes present to the imagination a picture of human misery and degradation from which it would be the part of wisdom to turn away our eyes and thoughts, if such a state of things were inevitable and irremediable; but it is not inevitable; much that is most deplorable in it is clearly and certainly capable of prevention, and it is therefore both a folly and a crime not to fix attention on it.

State of dwellings of the destitute when a death occurs in them.

123. Who can read such descriptions as the following without an emotion of horror, without a feeling of wonder that this can be a possible, nay, that it is the actual, that it is even the common and ordinary state of things, existing at the present moment in this Metropolis in hundreds of thousands of instances?

Crowded state.

"There are some houses in my district," says Mr. Leonard,* surgeon, one of the medical officers of the parish of St. Martin's in the

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* Report on the Sanatory condition of the labouring Population of Great Britain. Supplementary Report, p. 32, § 26.

Fields, "that have from forty-five to sixty persons of all ages under one roof; in the event of death, the body often occupies the only bed, till they raise money to pay for a coffin, which is often several days. In the lodging-rooms I have seen the beds placed so close together, as not to allow room to pass between them, and occupied by both sexes indiscriminately. I have known six people sleep in a room about nine feet square, with only one small window, about fifteen inches by twelve inches; there are some sleeping rooms in this district in which you can scarcely see your hand at noon day."

Spread of disease.

124. The following are among the instances given by this witness of the consequences to the survivors of the retention of the dead body in these crowded places. "I remember," he continues, "a body being brought from the Fever Hospital to Bullin-court; the consequences were dreadful. This spring I removed a girl named Wilson, to the infirmary of the workhouse, from a room in the same court. I could not remain two minutes in it; the horrible stench arose from a corpse which had died of phthisis twelve days before, and the coffin stood across the foot of the bed, within eighteen inches of it. This was in a small room not above ten feet by twelve feet square, and a fire always in it, being the only one for sleeping, living, and cooking in.

"Upon the 9th of March, 1840, M—— was taken to the Fever Hospital. He died there; the body was brought back to his own room. Upon the 12th his step-son was taken ill. Upon the 18th the barber who shaved the corpse was taken ill, and died in the Fever Hospital, and upon the 27th another step-son was taken ill.

"Upon the 18th of December, 1840, I—— and her infant were brought ill with fever, to her father's room in Eagle-court, which was ten feet square, with a small window of four panes; the infant soon died. Upon the 15th of January, 1841, the grandmother was taken ill: upon the 2nd of February the grandfather also. There was but one bedstead in the room. The corpse of the grandmother lay beside her husband upon the same bed, and it was only when he became delirious and incapable of resistance (on account of his violent objection to his own removal and that of the dead body from the room) that I ordered the removal of the body to the dead-house, and him to the Fever Hospital. He died there, but the evil did not stop here: two children, who followed their father's body to the grave, were, the one within a week and the other within ten days, also victims to the same disease. In short, five out of six died.

"I saw a family in Hervey's-buildings, which is more open, and the rooms of a better class than those in some other situations. I found there the corpse of a person who had died of a fever; the father and mother were just taken ill, and a child was taken ill soon after. The foot of the coffin was within ten inches of the father's head as he lay upon his pillow. I caused it to be removed as soon as possible, and the three cases terminated favourably."

In Whitechapel.

125. Mr. John Liddle, the medical officer of the Whitechapel district of the Whitechapel Union, says:* "In the eastern part of the metropolis nearly the whole of the labouring part of the population have only one room; the corpse is therefore kept in that room, where the inmates sleep and have their meals. Sometimes the corpse is stretched on the bed; the bed and bed-clothes are taken off and the wife and family lie on the floor. Only three or four days ago the following instance occurred:—A widow's son, who was about fifteen years of age, was taken ill of fever; finding the room small, in which there was a family of five persons living, witness advised the immediate removal of the young person; this was not done: two other sons were shortly afterwards attacked; and both died. When fever is epidemic, death following the first death in the same family is of frequent occurrence; and even in cases where the survivors escape, their general health is deteriorated by the practice of keeping the dead in the same room."

In Bethnal Green.

126. Mr. Bestow, relieving-officer of Bethnal Green,† states that the majority of weavers live and work in the same room; that the children generally sleep on a bed pushed under the loom; that in the case of death the corpse is stretched on the bed where the adults have slept, and that the length of time during which the bodies are kept under such circumstances is a very serious evil. "I have known," he says, "as many as eight deaths from typhus fever follow one death. A man named Clark, in George Gardens, having been kept a fortnight unburied, I was directed to visit the case. The house consisted of two small rooms, wherein resided his wife and seven children. Ann Clark, one of the family, was lying upon some rags, very ill in fever; she ultimately died. Shortly after, I found the mother and the whole of the children all ill of fever; out of seven affected, two died. My attention was shortly afterwards directed to Henry Clark, of Barnet Street, who was a relative, and had taken fever (it was stated) by having

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* Supplementary Report, p. 34, § 27.

† Ibid. p. 36, § 28.

attended the funeral of his friend; he, it seems, communicated it to his wife and two children, one of whom died; next followed Stephen Clark, of Edward Street, who, having visited the above-named relative, and attended the funeral of their infant shortly afterwards, had fever; also his wife and three children, one of whom died. I was called to visit the case of Sarah Masterton, No. 11, Suffolk Street, whose husband lay dead of fever; she was with two children in the same room, and the corpse not in a coffin. They were in a most deplorable condition, and so bad with fever that none of the neighbours would venture to enter the room with me."

City of London.

127. Mr. T. Abraham,* surgeon, one of the registrars for the City of London, says, that in an instance which came under his own observation, a man, his wife, and six children lived in one room in Draper's Buildings. The mother and all the children successively fell ill of typhus fever: the mother died; the body remained in the room; the children were apparently well at the time of the death of the mother; the body was kept five days in the only room which this family of eight had to live and sleep in. The eldest daughter was attacked about a week after the mother had been removed, and after three days' illness that daughter died. In about nine days after the death of this girl, the youngest child was attacked, and it died in about nine days. Then the second one was taken ill; he lay twenty-three days, and died. Then another boy died. The two other children recovered.

Parish of Stepney.

128. Mr. Barnett,† one of the medical officers of the Stepney Union, says, "A short time ago I was requested to attend a family consisting of five persons; they resided in a room containing about 500 cubic feet with but little light, and less ventilation; one child was ill, suffering from small-pox, and died in a day or two; the corpse was allowed to remain in the room; and two other children were soon attacked, as well as a child belonging to a person residing in the same house who was imprudent enough to bring it into this apartment. The stench arising from the living and the dead was so intolerable that it produced in myself severe headache, and in my friend who accompanied me sudden nervousness. The parents of these children (one of whom is since dead) are still suffering great debility.

Parish of Lambeth.

129. Mr. Wild,‡ an undertaker, states that in three-fourths of the cases he has to visit, the poor people have only a single room; that fre-

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* Supplementary Report, p. 37, § 29. † Ibid. p. 37, § 30. ‡ Ibid. p. 38, § 31.

ently, there is only one bed in the room, and that is occupied by a rpse; often there is no sacking to the bed, when the people have to bor-w a board or a shutter from a neighbour, in order to lay out the corpse on it; they have also to borrow other necessary articles, such as a irt. In cases of rapid decomposition there is much liquid, and the ffin is tapped to let it out; this liquid generates animal life very pidly; and within six hours after a coffin has been tapped, if the quid escapes, maggots, or a sort of animalcule, are seen crawling out; has frequently seen them crawling about the floor of a room habited by the labouring classes, and about the tressels on which the pped coffin is sustained; in such rooms the children are frequently ft whilst the widow is out making arrangements connected with the neral, and the widow herself lives there with the children; fre-uently finds them all together in a small room with a large fire. The her day a little boy died of the small-pox: soon afterwards his sister, little girl who had been playing in the same room, was attacked ith the small-pox and died; a poor woman, a neighbour, went over see one of these bodies and was much affected and frightened; she as attacked with small-pox and died. The other day at Lambeth e eldest child of a person died of scarlet fever; the child was four ears old; it had been ill a week; then came two other children, one hree years and the other sixteen months old. When the first child ied there were no symptoms of illness for three days afterwards; the orpse of the eldest one was in a separate room; but the youngest hild had been taken by the servant into this room: this child was aken ill and died in a week. The corpse was retained in the house hree weeks, at the end of which time the other child also died.

130. Mr. Jefferys,* an undertaker, residing in Whitechapel, gives imilar evidence. "I have known them," he says, "to be kept three weeks: we every week see them kept until the bodies are nearly putrid: ometimes they have run away almost through the coffin, and the poor eople, women and children, are living and sleeping in the same room at the same time." Then when the corpse is uncovered, or the coffin is open, females will hang over it. A widow who hung over the body of her husband, caught the disease of which he died: she died, leaving seven orphans, of whom four are now in an orphan asylum. A young man died not long since, and his body rapidly decomposed. His

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* Supplementary Report, p. 39, § 31.

sister, a fine healthy girl, hung over the corpse and kissed it; in three weeks after she died also."

The destitute cannot help themselves.

181. Such is the slaughter of the living by the dead, which goes on unceasingly. And these sufferers are incapable of helping themselves: they can neither alter nor prevent the wretched circumstances in which they are placed, nor raise themselves above them by any energy of their own: they are too impotent, too much depressed by the causes that destroy them, even so much as to raise a voice of complaint. "I attended," says one of the witnesses,* "a family of thirteen, twelve of whom had typhus fever, without a bed, in the *cellar*, without straw or timber shavings—frequent substitutes. They lay on the floor, and so crowded, that I could scarcely pass between them. In another house I attended fourteen patients: there were only two beds in the house. All the patients lay on the boards, and during their illness never had their clothes off. I met with many cases in similar conditions; yet amidst the greatest destitution and want of domestic comfort, *I have never heard, during the course of twelve years' practice, a complaint of inconvenient accommodation.* This want of complaint under such circumstances appears to me to constitute a very melancholy part of this condition. It shows that physical wretchedness has done its worst on the human sufferer, for it has destroyed *his mind*. The wretchedness being greater than humanity can bear, annihilates the mental faculties—the faculties distinctive of the human being. There is a kind of satisfaction in the thought, for it sets a limit to the capacity of suffering, which would otherwise be without bound."

Effectual relief may be afforded.

182. But is it right to allow evils of such magnitude to go on working out their own cure in such a mode and at such a cost? That they may be prevented, that they are within the control of human agency, is proved by the success of the first rude effort that was made to check them. It is on record† that there was a small house in Shepherd's Court, containing four rooms, two on the ground floor and two above, each room being let out to a separate family. On the occasion in question, in one of the rooms on the ground floor there were four persons ill of fever; in the other room on the same floor, there were at the same time three persons ill of fever; and in one of

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* Evidence of Dr. Southwood Smith, First Report, vol. i. p. 10.

† Dr. Southwood Smith's Report, Poor Law Commissioners' Fifth Annual Report, Appendix, p. 160.

the upper rooms there were also at the same time three persons ill of fever; in the fourth room no one was ill at that time. It appeared that different families had in succession occupied these rooms, and become affected with fever; on the occasion in question, all the sick were removed as soon as possible by the interference of the parish officers. An order was made by the board of guardians to take the case before the magistrates at Worship-street. The magistrates at first refused to interfere, but the medical officer stated that several cases of fever had occurred in succession in this particular house; that one set of people had gone in, become ill with fever, and were removed; that another set of people had gone in, and been in like manner attacked with fever: that this had occurred several times, and that it was positively known that this house had been affected with fever for upwards of six weeks before the present application was made. On hearing this, the magistrate sent for the owner of the house, and remonstrated with him for allowing different sets of people to occupy the rooms without previously cleansing and whitewashing them; telling him that he was committing a serious offence in allowing the nuisance to continue. The magistrate further gave the house in charge to the medical officer, authorising him to see all the rooms properly fumigated, and otherwise thoroughly cleansed; and said that, if any persons entered the house before the medical officer said that the place was fit to be inhabited, they would send an officer to turn them out, or place an officer at the door to prevent their entrance. The landlord became frightened, and allowed the house to be whitewashed, fumigated, and thoroughly cleansed. Since this was done the rooms have been occupied by a fresh set of people; but no case of fever has occurred. "This," says Mr. Chadwick,* "occurred seven years since, and on a very recent inquiry made at this same house, it was stated that comparative cleanliness having been maintained, no fever had since broken out, no more such deaths have been occasioned, no more burthens had been cast upon the poor's rates from this house. The law already authorises the house to be condemned, and its use arrested, when it is in a condition to endanger life by falling; if it be deemed that the principle should be applied to all manifest causes of disease or death, or danger to life, then, instead of the remote and practically useless remedy by the inspection of an unskilled and unqualified ward inquest

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* Supplementary Report, p. 165.

(vide General Sanatory Report, p. 300), the skilled and responsi medical officer, with such summary powers and duties of immedi interference, as were successfully exercised in the case above cit should be appointed. . . . .

Services of officer of health.

133. The effect of such an appointment would be to place the mo ignorant, forsaken, and helpless being in the community, in the mome of his utmost bewilderment and desolation, under the direction of a instructed mind; it would be to secure universally and invariably, th presence of knowledge and science in the abode into which deat follows the footstep of disease, and in which are present the conditio that are necessary to give instant birth to pestilence, and to arm it wit appalling power. With the visits of the policeman, the rent-collecto and the tax-gatherer, the poor are familiar; they see also the unio surgeon, and the officer for administering parochial relief; occasionall the agent of some charitable society, and sometimes the clergyman; but there is no responsible officer whose proper duty it is to visit them in the season of distress and sorrow, for the express purpose of affording them protection, counsel, and help. The medical officer of health, with the qualifications here supposed, would be such an officer; hi mission would be one purely of benevolence, and most healing an beneficent would be the influence of the appointment by the state of such a public servant for such a purpose. It may be necessary to ar him with certain summary powers—with the power, for example, to place the dead body, during the interval between death and interment, under circumstances which will secure it from injuring the living; to enforce ventilation, when it is obviously necessary to the safety of survivors, and summarily to remove nuisances which originate an maintain disease. But experience shows that in the great majority of cases the poor would be willing co-operators with the officer of health in avoiding or removing manifest sources of danger. The pains which it may be necessary to take to enable them to understand the reasons of the measures recommended, would bring them into beneficial communication with this public servant; and an instructed and able mind thus treating them with respect and sympathy, and obviously labouring for their benefit, could scarcely fail to gain their confidence, to acquire an influence over them, and almost unconsciously to give to their natural feelings (now too often prompting them to observances and courses mischievous to themselves and to those around them) a bene-

tial direction. There is at present no machinery in our institutions r bringing the uninstructed classes into direct and systematic comunication with the instructed; here is a means of doing so on a scale universal as to reach directly or indirectly to every individual of e former, and under circumstances the most favourable that can well e conceived for the exertion of the beneficial influence of the latter.

Objection against domiciliary visits.

134. In the mean time the objection against making it compulsory the medical officer of health to visit every house in which death takes lace, that the people are not prepared for such domiciliary visits, and hat they would not be acceptable, is probably an apprehension without ny real foundation. The station and education of the officer of health ould be a sufficient security that his professional visit could not afford nnoyance to the higher classes, while his visit must often be serviceble to them in various ways. They have been long accustomed, henever death took place, to the visits of two old women under the ame of searchers, whose duty it was to ascertain, to the best of their ower, the fact and the cause of death. The agents were absurdly nfit for the task assigned them, and the office is now abolished; but his example shows that domiciliary visits have been actually and regurly paid, for the very purpose in question, from a remote period.

Experience of the local registrars.

135. On the other hand, the experience of the local registrars affords irect evidence that the visit of the officer of health would not be uneceptable to the humbler classes. On account of the difficulty of ealing satisfactorily with common hearsay evidence, some of the local egistrars have found it necessary in the performance of their duty to erify the fact of death by personal inquiries made at the house in hich the event is reported to have taken place. The evidence of hese officers as to the manner in which they have been received is ecisive of the question; it is uniformly to the following effect:

Thus the Registrar for the Hackney Road District of Bethnal Green Mr. James Murray), after stating that he is very much in the habit of aking inquiries on the spot for the registration of deaths, says*—"I m always received with civility in all cases; my visit is never conidered an intrusion; I have never met with any instance of incivility mong them."

Mr. John Johnson, the Registrar of one part of the Shoreditch Disrict, says:†—"When we go to register deaths at the houses of the labouring classes, we are in general very well received; they consid we pay them a compliment in calling on them; they do not deem o registration or inquiry at all an intrusion."

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* Supplementary Report, p. 169, § 101.

† Ibid.

Mr. W. H. Wheatley, the Registrar of the Old Church Distric Lambeth, says*—"Has never met with the slightest obstruction o observed the slightest indication of bad feeling on the part of the poore classes; they never regard the registrar as an obtrusive officer."

Mr. P. H. Holland, surgeon, registrar of Chorlton-upon-Medlock Manchester, states that he has made inquiry of some hundreds of per sons on subjects connected with the existence of annoying and injuriou nuisances in or near their dwellings, and that in not one single instanc has he ever met with the slightest incivility, or has any obstacle eve been opposed to his investigations. On the contrary, all have appeare not merely willing, but anxious to render every assistance in thei power in pointing out the existence of anything they suspected to b injurious to themselves or others. There is no doubt whatever that a Officer of Health would receive the most cheerful assistance from al classes of the community, except perhaps, at first, from the owners o small cottage property, who might fear that they may be forced int placing the houses they let in such a condition as that they may b inhabited without destroying the health of the inmates. This oppo sition would, however, quickly die away, as they would find th with the improved salubrity of their houses, would grow up a mor healthy and comfortable, a more respectable, moral, contented, an *better rent-paying* tenantry.

But the visit of the officer of health to the house of the poor man o the occasion in question would be a visit of benevolence as well as a inquiry for a civil purpose; and experience as far as it goes is complete in favour of the conclusion that the higher service here indicat would not only be acquiesced in, but would be thankfully received.

Officer of health would thus ascertain the true cause of death.

136. No one now questions the importance of an accurate return a to the cause of death. From an inquiry on the spot concerning th train of symptoms preceding death, from the general examination o the body, and from conversation when necessary with the medical attendant of the deceased, the true cause of death would be ascertained by the officer of health probably with as much accuracy as is practicable. Large classes of cases would thus come under the eye of one ob-

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* Supplementary Report, p. 170.

ever, fitted by education and practised by the business of his office
r analyzing symptoms, and tracing the connexion between cause and
ffect. A body of information would be gradually acquired on the
fluence of general local circumstances, on the influence of particular
gents in connexion with trades and manufactures, on the influence of
pecial circumstances in giving origin to epidemics, in increasing their
ntensity and in favouring their spread; and from the labours of a
ody of men thus employed for the whole community, and periodically
eporting the results of their observations, a foundation would be laid
or the science of prevention, the value of which it is impossible at
resent to appreciate.*

Science of prevention.

137. Man has but little power over the progress of disease when
nce it is produced; but he may exercise a very important control over
he circumstances and conditions that give origin to it, when those cir-
umstances and conditions are once ascertained. But the difficulty is
o arrive at a certain knowledge of these; that is, at a certain know-
edge of the true causes of disease. It has been observed by Dr. W.
Pulteney Alison, that the living body often assumes different kinds of
iseased actions without any apparent or known causes. It is probable
hat the true causes are certain circumstances in the situation or con-
ition of the individuals before the diseases appear. Of these however
re have no other proof than the observation that persons known to be
xposed to their influence become afflicted with certain diseases in a
roportion very much greater than those who are not known to be so
xposed. This kind of evidence is in many *individual* cases very liable
o fallacy, in consequence of the great variety of the circumstances
apable of affecting health, in which individuals are placed, and the
ifficulty of varying these so as to obtain such observations, in the way
f induction or exclusion, as shall be decisive as to the efficacy of each.
Hence the importance of the observations intended to illustrate this
atter being as extensively multiplied as possible; and hence also the
peculiar value, with a view to the investigation of the causes of dis-
eases, of observations made on large and organized bodies of men, as
in the experience of military and naval practitioners. All the circum-
stances of the whole number of men whose diseases are there observed,
are in many respects exactly alike; they are accurately known to the

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* See Evidence of Mr. John Liddle before the select committee on Medical Poor Relief, p. 144, § 2017.

observer, and are indeed often to a certain degree at his disposal; they are often suddenly changed, and when changed as to one portion of the individuals under observation, they are often unchanged as to another, and therefore the conditions necessary to obtaining an *experimentum crucis* as to the efficacy of an alleged cause of disease are more frequently in the power of such an observer than of one who is conversant only with civil life."

Capable of being applied to towns and cities.

138. But in towns and cities large classes of persons often exist under conditions as well defined and as steady in their operation as the circumstances presented to the observation of medical officers of the army and navy; the knife-grinders of Sheffield, for example, the ironmongery and toy manufacturers of Wolverhampton, the persons employed in particular departments of colliery and factory labour, persons who work together in large numbers in common workshops, as tailors, dressmakers, &c. In each of these cases, and there are many others, the circumstances injurious to health are common to great numbers; they are steady in their operation, they are uniform in their result; the connexion between cause and effect can be clearly traced, and in this manner the efficacy of some particular remote cause in producing some peculiar form of disease may be determined statistically and with absolute certainty, and knowledge of the highest importance may be thus acquired, leading directly and certainly to the *prevention* of disease. What additions may be made to our knowledge of these causes and of the means of counteracting and removing them by the combined and continued labours of such a body of public servants, it is impossible to predict; but surely these observations indicate a new direction in which protection of the highest kind may be extended to the community, and especially to the poorer classes, that well deserves the attention of the statesman.

Correct registration of the fact and cause of death.

139. Further, the correct registration of the fact and the cause of death would put an end to false registration, at present not unfrequently made for fraudulent purposes; it would present perfectly trustworthy materials for constructing and correcting tables of assurance; it would facilitate the recovery of the sums of money assured, and as the present local registrars might act as auxiliaries to the officers of health, it would most materially improve the machinery for local registration in general.

Supervision of parochial medical relief.

140. There is another service, of great public importance, which the medical officer of health might perform, namely, a supervision of

the established parochial medical relief. It has been observed by Dr. Southwood Smith,* that if it has been found necessary to appoint inspecting surgeons in military hospitals, and if unquestionable good to the service, in various modes, has resulted from this appointment, the necessity that there should be some supervision over such a body of men as are at present intrusted with the medical and surgical treatment of the poor, is much greater; and that the advantage of such inspection in this instance would be of proportionate magnitude. If among such a numerous class of medical men as the parish surgeons, a considerable portion of whom are young and comparatively inexperienced, there is no incompetence, no error, no neglect, still the public has at present no security of this, and it is a security to which, if it can be given, the public are entitled. The most able of the guardians will be the most ready to admit that they are very incompetent to exercise the requisite control over this large body of their officers; and there must be occasions on which the Poor Law Commissioners themselves, as well as individuals among the most conscientious, the best instructed, and the most skilful of the medical men attached to the unions, must stand in need of the counsel and aid of a medical officer, filling comparatively a high station, and distinguished for his science and integrity. That such an officer exercising jurisdiction over the parochial surgeons of his district is needed, none will dispute who are acquainted with the parochial administration of the established medical relief, and the appointment of this officer will probably give unmixed satisfaction to the poor themselves, to the great body of medical men intrusted with their care, to the boards of guardians, to the Board of Commissioners, and to the public.

Check on crime.

141. Finally, there is one more service which the officer of health might render that deserves particular notice. In the very performance of his duties as a responsible officer employed to verify the fact and the cause of death, he would necessarily exercise a powerful additional check on crime. In England and Wales there are upwards of 700 commitments to prison annually for crimes of violence, 450 being for manslaughter, murder, or attempts at murder—a state of things which sufficiently indicates the importance of instituting the best security that can be devised for the protection of life. To such an extent are the safeguards of life removed in the worst districts, the resort, as has

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* First Report, vol. i. p. 37.

been shown, of the great and most reckless criminals, that the darkest crimes may be perpetrated with considerable chance of impunity; and we know, from melancholy experience, that sometimes they actually continue to be committed for an indefinite period, until accident leads to their discovery.

Evidence of Mr. Corder.

142. There would scarcely be a possibility of this, under a strict verification in every case of the fact as well as of the cause of death. This, at least, is the conviction of those whose official experience qualifies them to form an opinion on the subject. Thus, among other witnesses, Mr. Corder, the Superintendent Registrar of the Strand Union, says:* "Had there been such an inspection and verification prior to the year 1831, the horrible system of destroying human beings for the purpose of selling their bodies could not have been carried on to the extent to which I know it existed at that period. Being then the vestry clerk of St. Paul, Covent Garden, the officers of which were bound over to prosecute Bishop, Williams, and May, for the murder of the Italian boy, the duty of conducting the prosecution entirely devolved upon me. In the course of my inquiries, I elicited beyond all doubt that the practice of burking, as it was then called, had prevailed to a considerable extent in the metropolis. I conceive that inspection and proper inquiry as to the cause of death would have prevented such murders. Though the motives to these dreadful practices are removed under the securities for the public safety imposed in connexion with the Anatomy Act, yet, in cases of other attempts against life, I do consider that the requiring a certificate of the fact of death, verified on inspection before burial, would interpose useful practical obstacles for the prevention of murder, and the protection of life."

Evidence of Mr. Partridge.

143. Mr. Partridge, the Professor of Anatomy at King's College, at whose instance these murderers were taken into custody, expresses† a similar opinion as to the importance of the proposed verification of the fact and cause of death by the officer of health.

Evidence of Mr. Abraham.

144. Mr. Abraham, Surgeon and Registrar of Deaths in the City of London Union,‡ states that since he has been registrar, he has had occasion to send notice to the coroner of cases where the causes of death appeared suspicious in six instances; that he may very possibly have passed over cases of murder; that there is at present no security

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* Supplementary Report, p. 171, § 202.

† Ibid. p. 172.

‡ Ibid. § 203.

gainst this, but that the personal inspection of the deceased would undoubtedly act as a very great security.

145. Mr. P. H. Holland,* Surgeon, Registrar for Charlton-on-edlock, states, that though his district is of a better description, inabited either by the higher classes or by respectable working men, in hich cases of death from crime are not very likely to occur, yet that uspicious cases do from time to time happen, in the proportion of six to ight annually. In one case, for example, he says, "A father, a labourng man, came to me to report the death of his infant child, stating the ause to be sickness and purging; there was then no cholera prevalent, nd the rapidity of the disease was unusually great. My suspicion was xcited as to the cause of the death, of which the father could give no lear account, and I sent word to the coroner that I thought the case as one which required inquiry. An inquest was held, and it turned ut that the child had taken arsenic. The jury were of opinion that he death was entirely accidental,—that there had been no criminal ntention. Had not the cause of the accident been developed by the nquiry, others of the family might have suffered in the same way. The other cases, which had escaped inquiry, have been chiefly those of ccident, in which the death occurred at long periods subsequently, uch as five or six weeks. Inspection on the spot would, I consider, perate much more powerfully in prevention than in detection of rime."

Evidence of Mr. Holland.

146. Mr. W. Dyce Guthrie, after reciting several cases of strong uspicion which came under his own observation, and expressing his conviction of the importance of affording every facility for arriving at the truth, in all circumstances connected with sudden and suspicious deaths, says†—"I could cite many instances of sudden deaths attended by circumstances of such a nature as not only rendered an investigation highly proper in a legal point of view, but necessary in charity to those individuals whose characters were tarnished by the cruelly unjust insinuations of some black-hearted enemies. The business not having been thoroughly probed at the time of its occurrence leaves great latitude for the villainous conjectures of parties whose interest it may be to damage others in the estimation of the public."

Evidence of Mr. Dyce Guthrie.

147. Dr. Scott Alison states ‡ that, in Scotland, there is full opportunity for the perpetration of murder, and burial without investigation

Evidence of Dr. Scott Alison.

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* Supplementary Report, p. 173, § 203.

† Ibid. p. 175.

‡ Ibid. p. 175.

by any responsible officer; that there is no coroner and no inque that he has himself known many cases of death from culpable ne gence, and still more from culpable accident, which required st investigation, but in which no inquiry took place or was thought and that the present facility for the perpetration of murder would greatly checked by the visits of an officer of public health.

Evidence of Mr. William Chambers.

148. Mr. William Chambers observes*—"It seems to be not a li surprising that in Scotland, which is signalized for its general inte gence, love of order, and I may add really beneficent laws, the coun should be so far behind in everything connected with vital statis I have already noticed that it possesses no coroner's inquest. This i positive disgrace. Deaths are continually occurring from violen but of which not the slightest notice is taken by procurators fisc magistrates, or police; indeed, these functionaries seldom interfe except when a positive complaint is lodged. Some time ago, the m dical gentleman who attends my family mentioned to me incidental that that morning he had been called to look at, and if possible r covery, a lady who had been found hanging in her bed-room. H efforts were ineffectual; the lady was stone dead; and it was announce by her relatives that she had died suddenly. In the usual course things, she was buried. Now, in this case, not the slightest inqui was made by any public officer, and whether it was a death fro suicide or from murder nobody can tell. The procurator fiscal, who duty it is to take cognizance of such deaths, is, of course, not blame, for he has not the faculty of omniscience."

Evidence of Mr. Hill Burton.

149. Mr. Chadwick justly observes that the preventive and detect functions of the officer of health would be the more efficient from exercise of such functions being incidental to ordinary function acknowledged every-day importance, which must lead his visits inspection to be regarded as *primâ facie* services of beneficence kindness to all who surround the deceased. The comparative in ciency of officers whose functions are principally judiciary is thus emplified by Mr. Hill Burton, Advocate:—"A prominent defect observes) in the means of inquiry into the causes of death in Scotl consists in the circumstance that before any investigation can be tered on, there must be ostensible reasons for presuming the existe of violence and crime. On the occasion of a death having occur

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* Supplementary Report, p. 175.

circumstances 'out of the ordinary course,' the only person authozed to make any inquiry as to its cause is the officer whose proper nd ostensible duty it is to prosecute to conviction. It hence arises at the simple institution of an inquiry is almost equivalent to a harge of crime, and that the proper officer, knowing the serious po- tion in which he places those concerned, by taking any steps, is very eluctant to move, until the public voice has pretty unequivocally hown him that the matter comes within his province as a public pro- ecutor. There is no family in Scotland that would not at present feel demand by a procurator fiscal, or by any individual to inspect a body ithin their house, as very nearly equivalent to a charge of murder; nd I should think it is of very rare occurrence that any such inspecion takes place, in a private house, unless when a prosecution has been ecided on.

"The absence of any machinery, through which an inquiry can be almly and impartially made into the cause of death, without in itself mplying suspicion of crime, is frequently illustrated in the creation of xcitement and alarm in the public mind, which the authorities cannot ind a suitable means of allaying. I remember some years ago being resent at a trial for murder, which, as it involved no point in law, as unfortunately not been reported. It was a trial undertaken by the rown for the mere purpose of justifying an innocent man. Two utchers were returning tipsy from a fair; some words arose between hem, and soon after one of them was found stabbed to the heart by ne of the set of knives which both carried. On investigation, it appeared that the deceased had fallen on his side, from the effects of runkenness, and that one of the knives which hung at his side, dropping perpendicularly with its heavy handle to the ground pierced through his ribs to his heart as he fell. It was impossible, however, to satisfy the public that such was the case. The feeling of the neighbourhood ran high, and the Crown was induced, out of humanity, or from a desire to preserve the public peace, to concede the formality of a trial. I know it to be of most frequent occurrence, especially in the north of Scotland, that suspicions which must be destructive to the peace of mind of those who are the objects of them, take wing through society, and can never be set effectually at rest."

150. The public officers in England whose duty it is to make investigations of this kind, and who from their official situation and expe- **Testimony of coroners.**

rience have the best means of judging of the necessity of the medical officer of health, and of the value of the services which he would be likely to render, bear such testimony as the following: Thus Mr. Payne, the Coroner for the City of London, states that he has in some cases felt it to be his duty to send a confidential person to make inquiries for him before he would act on the ordinary sources of information in holding inquests; that other coroners are under the necessity of adopting the same practice; that it is frequently found necessary to incur the trouble and expense of previous inquiries by more trustworthy persons, in cases where the alleged cause of death is not manifest; and that medical officers of health would, by the very exercise of their ordinary duties, relieve the coroners from this necessity, and at the same time give the public cause to be better satisfied that no really suspicious cases were shrouded in obscurity, and that none escaped investigation from inadvertence. "I have long felt," says this witness, "that there has been something wanting in the machinery by which inquiries into deaths are or ought to be regulated. In cases of death from external violence, where the injury is apparent, the constable of the district is fully aware of the necessity of applying to the coroner; but in cases of sudden or other deaths where there is no cause apparent to a common observer, there is a necessity for some qualified person forming a judgment as to the expediency of a judicial inquiry into the cause of death, and I know of none so well qualified to form such a judgment as a member of the medical profession. The office of searcher, when properly carried out, was useful as far as it could be in the hands of old women; but that could only apply to cases in which external violence was apparent to the view on searching the body. I believe, however, that the office has now ceased to exist, and the present mode of registering deaths does not supply any means of detecting unnatural or violent deaths. I am therefore quite of opinion that a medical registrar (chosen for his ability and *discretion*), who would not unnecessarily annoy the feelings of private families, and yet make himself acquainted with the death by personal knowledge, would be a valuable addition to the present mode of ascertaining and registering deaths."

Window Duties.

151. There is one subject so intimately connected with sanatory improvement that no sanatory measure can be tolerably complete without embracing it, which is wholly passed over in Lord Lincoln's Bill, into the investigation of which Her Majesty's Commissioners

nter but slightly,[*] and of which they take no notice in their Recommendations; namely, the operation of the window duties. The window duties are a tax upon light and air; a tax more vicious in principle and more injurious in its practical consequences than a tax upon food. The facilities for procuring food increase with wealth, which is always greatest in towns and cities, precisely where the difficulties of obtaining light and air increase with every street that is laid down, and almost with every house that is built. That was therefore a most unhappy thought which suggested to the legislature the scheme of laying a tax upon windows, the inlets to light and air. A wise legislature, understanding its duties, would have met such a proposition in this spirit:—"Upon the most skilful arrangement of houses in towns and cities that can be devised, it is difficult to admit to the rooms sufficient light and air. This difficulty must necessarily increase as a city enlarges and the number of streets and houses increase. We ought under such circumstances rather to offer a bounty to builders for plans that may secure to houses the admission of the largest amount of light and air. Nature, which has made these elements indispensable to human existence, has provided them for the use of human beings freely, in unlimited abundance. It is not for us to step in between God and the people, and by laying a tax upon the light of Heaven and the breath of life, to render them absolutely unattainable by large classes of the population." A wise legislature, understanding its duties, would have acted in accordance with this feeling; for it would have foreseen what has actually happened, that the operation of the window duties would be to shut out the sun from multitudes of human beings, and to compel them to breathe, in darkened rooms, a poisoned air.

Operation of Window Duties.

Influence of Light.

152. The consequences to the people of breathing this poisoned air have been fully shown; but the consequences of living in dark rooms, to which no ray of sunshine ever penetrates, are not so generally known, though they are well understood by those who have attended to the subject.

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[*] The evidence of N. B. Ward, Esq. on the "influence of light and air on vegetable and animal life," possesses peculiar interest and importance, and his suggestions with regard to air-tight cases for plants, adapted to the rooms of the poor, and affording a new pleasure, and a healthy, economical, and even remunerative recreation, is highly deserving the attention of all who aim at the improvement of the people."—*First Report*, vol. i. p. 41, *et seq.*

Necessary to animal as well as vegetable nutrition.

153. The necessity of light to the nutrition of the plant is matter o familiar knowledge, but it is not so generally known that light is al essential to the nutrition of the animal. It is proved by direct experiment and by large experience, that without light, the development o the animal body stops at certain, and in some cases at definite stages. Thus, if the young of some of the lower tribes of creatures are supplied with their proper food, and if all the other conditions necessary fo their nourishment are maintained, while at the same time light is wholly excluded from them, their development is stopped; they no longer undergo the metamorphosis through which they pass from imperfect into perfect beings; the tadpole, for example, is unable to change its water-breathing apparatus, fitted for its first stage of existence, into the air-breathing apparatus, with the rudiment of which it is furnished, and which is intended to adapt it for a higher life, namely, for respiration in air. In this imperfect state it continues to live; it even attains an enormous bulk, for such a creature in its state of transition, but it is unable to pass out of its transitional state; it remains permanently an imperfect being, and is doomed to pass a perpetual life in water, instead of attaining maturity and passing its mature life in air. The same cause produces the very same effect upon human beings; upon human mothers, and upon human children. Human mothers living in dark cellars produce an unusual proportion of defective children. Go into the narrow streets and the dark lanes, courts, and alleys of our splendid cities, there you will see an unusual number of deformed people, men, women, and children, but particularly children. In some cells under the fortifications of Lisle, a number of poor people took up their abode; the proportion of defective infants produced by them became so great that it was deemed necessary to issue an order commanding these cells to be shut up. The window duties multiply these cells of the fortifications of Lisle in London, in Liverpool, in Manchester, in Bristol, and in every city and town in England by hundreds and by thousands, and with the same result; but the cells here are not shut up, nor is the cause that produces them removed.

154. Even in cases in which the absence of light is not so complete as to produce a result thus definite and striking, the effects of the privation are still abundantly manifest in the pale and sickly complexion, and the enfeebled and stunted frame; nor can it be otherwise, since, from

he essential constitution of organized beings, light is as necessary to he development of the animal as it is to the growth of the plant.

Window Duties deteriorate the people.

155. In proportion then as the window duties exclude light from uman dwellings, they tend to deteriorate the population; they interpose positive and definite obstacle to the full development of the physical onstitution, and consequently of the physical strength and vigour of he people.

Act as a premium on the bad construction of houses.

156. But it is remarkable that over and above this evil, inherent in the ery nature of the tax, the particular mode adopted in its assessment ecures practically the production of this evil in its greatest intensity, ust as if it were skilfully planned for this special purpose. The tax s so managed as to operate as a premium upon the defective and vicious construction of houses. Thus, windows are charged by a scale, the tax increasing at an average rate of about 8*s*. 3*d*. for every window, whether large or small. "Hence the number of windows," says Mr. Hickson,* "becomes to builders of second and third class houses a very serious consideration. Supposing a house to contain twelve rooms, if, to make these rooms cheerful and pleasant, I have put two windows in each room, and thereby ensured a current of air passing from back to front, the window tax for that house amounts to 7*l*. 5*s*. 9*d*.; but if I have put but one window to each room, the window-tax is but 2*l*. 4*s*. 9*d*., showing a difference of 5*l*. 1*s*. per annum; and I need scarcely say that a difference of only 10*s*. per annum is quite enough to influence builders of cheap houses in trying to save such a sum. But the same considerations affect the building of even first class houses. I have been offered a rent of 210*l*. per annum for a house unbuilt, on condition that the plan should be altered so as to reduce the amount of the window-tax, for which the house would otherwise be liable. The consequence is, that in the majority of new houses, one large window, of the largest size allowed, is made to serve the purpose of two windows; and privies, closets, passages, cellars, roofs—the very places where mephitic vapours are most apt to lodge—are now left almost entirely without ventilation. An opening only a foot square, even if intended merely to admit the air, and not glazed against the weather, makes the house liable for an additional 8*s*. 3*d*. per annum. I spoke but lately to a man in humble circumstances who had put in his privy a single pane of glass; it was discovered by the assessor, and rather than pay

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* First Report, vol. ii, p. 238, *et seq.*

the tax (the money being an object) the pane of glass was remove and the opening bricked up. I am paying for one of my new building in Whitefriars Street, East Temple Chambers, 14*l.* 8*s.* 9*d.* windo tax upon 44 windows. There are three waterclosets, one of them dark One of my tenants wished me to put in a window to this dark wate closet, and I should have done so, but this one additional windo would make me subject to an increased window-duty of 28*s.* Th charge after 39 windows is by *jumps*—

40 to 44 — £14 8*s.* 9*d.*
45 — 49 — 15 16 9, &c.

"From the way in which the window-tax is levied," says Mr. H Biers,* an extensive builder, "I have been obliged in several buildings I have lately constructed, and they are buildings of a sup rior class, to do away with some of the ventilating lights, such a under the steps; and in the larders, outhouses, and so on, where should have had two, three, or four, there is now but one; the assess can charge the tax if the opening is in an external wall; if it is mer a hole to let off the impure air, the tax-gatherer will charge for window."

157. There is no provision in any one of the Acts relating to the a sessed taxes for excepting from the duties chargeable on windows, op ings of any kind made for purposes of ventilation in dwelling-houses. O the contrary, the 30th Geo. III. chap. 40, expressly provides that a openings in external walls, not chargeable as windows or lights, sh be stopped up with brick or stone, or the materials of which the w is composed. Under this Act a gentleman of Croydon, who wished t rid himself of mice, was lately surcharged for a small hole in his cell made to admit a cat; and there is no exception in favour of perforate plates of zinc, or of any other mode of ventilation.

Exemption no relief to the poor.

158. Houses having less than eight windows are indeed exempt fro the duty; "but the window-tax," says Mr. Hickson, "is not therefo inoperative† as it regards the working classes of towns. In Lond the poor do not live in cottages, but several families occupy lodgin in the same house, and that perhaps a house built with the maximu of untaxed windows allowed by the law. One more window wou possibly let a little sunshine into a sick room; but the landlord say

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[*] First Report, vol. ii. p. 233, *et seq.*

[†] First Report, vol. ii. p. 240.

n, the house would then have eight windows, and I should be liable a tax of 16s. 6d. per annum. If the Commissioners would examine rsonally the houses in which the poor live in the close courts and leys of the metropolis, they would be surprised at the number of rk staircases and filthy holes which, although in upper floors, are uite as ill ventilated and unfavourable to health as the cellars of iverpool. And the permanent cause of this state of things is the tion given to builders of saving money in taxation by shutting out r and light."

Unequal pressure of the Window Duties on rich and poor.

159. In London and other cities many families of the poor live ider the same roof in one large building, just as many individuals nong the rich live in the Albany, in the Inns of Court, and in e Universities of Oxford and Cambridge. By the manner in hich the window-tax is levied, the poor, living in their large build gs, are actually made to pay upwards of four times the amount of indow-tax that is demanded of the rich in such buildings as the lbany, and in the Inns of Court and Universities. Thus, by the 6th ule in Schedule A, appended to the 48th Geo. III., ch. 55, it is de rmined that "when any dwelling-house is or shall be let in different artments, tenements, lodgings, or landings, and shall be inhabited y two or more persons or families, the same shall nevertheless be arged as if such house was inhabited by one person or family only;" hile by the 8th Rule of the same Act, "every distinct chamber or partment in any of the Inns of Court or of Chancery, or in any ollege or hall in either of the Universities of Oxford or Cambridge, all be subject to the same duties as if the same was an entire house;" that whatever number of families live in the building occupied by e poor, it is regarded only as one single house; whereas in the uilding occupied by the rich, every distinct chamber or apartment regarded as a separate house. In the case of the poor, twenty parate dwellings in one house still make but one house; in the se of the rich, twenty separate dwellings in one house make twenty parate houses. The effect of this distinction, as has just been stated, to make the poor pay quadruple the amount of window-tax aid by the rich. Thus, in the case of the buildings about to be rected by the Metropolitan Association for improving the Dwellings f the Industrious Classes, in a house for ten families, each house aving three rooms and a scullery, and each room containing one win-

Poor pay quadruple the amount of Window Tax paid by the rich.

dow, making forty windows throughout the house, and a skylight, the total window-tax for such house is 15*l.* 15*s.* 7*d.*, or 1*l.* 11*s.* 9*d.* for each family, being at the rate of 7½*d.* per week each; whereas, for the same house situated in the Inns of Court, or in either of the Universities of Oxford and Cambridge, the total duty is only 3*l.* 17*s.* per annum, or 7*s.* 8½*d.* for each set of four rooms; being at the rate of 1¾*d.* per week each.

160. W. Laird, Esq., of Liverpool, makes the following statement:—"In the beginning of the present year I built in Birkenhead two blocks or houses, each containing eight separate dwellings, in respect of which I, as the landlord, have been assessed to the window-tax in the sum of 27*l.* 2*s.* 10*d.* My houses I built expressly for the accommodation of the working classes, furnishing them with every convenience in the way of ventilation, drainage, water, and interior fittings, and on a plan something similar to the houses proposed to be erected by the Metropolitan Association, marked C in their prospectus. I have appealed against the assessment. I have however been informed by one of the Commissioners for Assessed Taxes for this district, that the assessment will be confirmed, the Commissioners having taken the opinion of the Judges in London upon the point, who are of opinion that the Act of Parliament imposing the window-tax clearly applies to the buildings in question."

161. Thus, for the same number of windows for which the rich living in London, in Piccadilly, at the Albany, and in the Inns of Court, or in Oxford and Cambridge at the Universities, pay 7*l.* per annum, the poor of Liverpool are required to pay 27*l.* 2*s.* 10*d.* Whatever may become of the window duties, as long as this most iniquitous inequality in the assessment is allowed to remain, it will be a disgrace and a scandal to the Statute Book.

Principle of New Assessment.

162. When the new Building Act was under discussion, a simple and it is submitted a very effectual mode of improving the healthfulness of the inferior class of habitations in great towns was earnestly pressed upon the attention of the Earl of Lincoln. The Earl of Lincoln declined to interfere with the province of the Chancellor of the Exchequer, and two applications made to Mr. Goulburn from persons well known to have paid great attention to the matter, failed to convince him that the subject was one of the slightest moment. The plan proposed was that windows charged for should be in proportion to the

ace enclosed, or to the number of rooms; that the *maximum* should fixed to the existing window duties, beyond which new openings ight be made for light and ventilation, without subjecting the occu- er to additional charges. The Chancellor of the Exchequer was licited to introduce a short Bill on this principle, and to exempt om taxation on sanatory grounds all unglazed openings in basement ories and closets of every description. But this was peremptorily fused.

Lord Althorp's Act.

163. It is remarkable, however, that when Lord Althorp was Chan- ellor of the Exchequer, a bill was actually introduced and passed with view to carry out this very plan. "If the noble lord," said Mr. lume,* "would limit the tax to its present amount, and allow every an who has paid the window-rate for an entire year to continue to ay the same composition and to open additional windows, it would be very great relief." The week following Lord Althorp rose and aid:†—"I have now to beg leave to bring up a clause enabling per- ons to open fresh windows in houses at present existing without any dditional charge." But unfortunately some one, either by inad- ertence or with a sinister design, introduced into the Bill the words 'duly assessed." Thus the 4th and 5th of William IV., chap. 54, lause 7, provides that "additional windows may be opened, free of luty, in every house which is or shall be *duly assessed* for the year nding April 5th, 1835." But the Commissioners of Stamps and Taxes immediately found out that no one was duly assessed in that year, and the lawyers supported them in this opinion; so that the pledge given to the people by Parliament, and the clear and unmistakeable intention of this Act, has been deliberately evaded for the sake of revenue. Without suspecting the interpretation that would be put upon these words, many thousand persons in all parts of the country immediately set about improving the cheerfulness, comfort, and healthfulness of their habitations by opening additional windows. What was the consequence? Every person, without one single exception, who opened additional windows upon the faith of Lord Althorp's Act, was surcharged for the increased number, some on one pretext, some on another. The case was brought before the Judges in innumerable shapes, but always in vain: the Judges invariably ruled in favour of the view taken by the Board of Stamps and Taxes; so that

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* Mirror of Parliament, p. 2757 of vol. for 1834.

† Ibid. p. 3116.

this Act, instead of being a relief to the people, has proved to them a mockery and a snare.

164. Certainly legislation for the people has hitherto been singularly unfortunate. When they rejoice that the air of their towns and cities is at length to be purified from the nuisance of smoke, their joy is destined to be short-lived; for the Act contains the words "in respect of every week during which such furnace or annoyance shall be so used:" and as the chimney of no furnace can be proved to smoke for one "whole" week, day and night, without interruption, all chimneys are allowed to go on as before, pouring out their dense columns of black smoke. When the people rejoice that on the payment of a fixed sum they are to be allowed to introduce into their houses as much light and air as they please, their joy is destined to be equally short-lived, for the Act contains the words—"by all persons duly assessed;" and as no person was duly assessed (though due assessment depends on no private individual, but on a public officer, the assessor), the openings they had so quickly made for the admission of air and light, they were obliged again as quickly to close.

165. It is submitted that the following statements, with which Mr. Hickson* closes the peculiarly valuable evidence given by him before Her Majesty's Commissioners on the subject of the window duties, deserves the serious attention of Her Majesty's Government, contemplating the introduction of a large and efficient sanatory measure:—"I do not expect in the present state of the revenue to see the window-tax repealed, but the revenue gains nothing by the present mode of assessment, while the public sustains a most serious injury. I would submit that all new houses should be assessed upon the principle that every house built requires for light and air a certain number of openings in proportion to its cubic contents, and that these openings should be paid for whether they exist or not. This would at once remove every temptation to defective construction; and I think that after a house had been once assessed, the proprietor should be at liberty to make as many additional openings as he pleased; in fact, to turn the whole of the walls into glass if he thought proper. I most sincerely hope that the serious and earnest attention of the Commission will be given to this part of their inquiry. A great practical improvement can be effected without any loss to the revenue, and by a few very simple

Her Majesty's Government contemplating the introduction of a large and efficient Sanatory Measure.

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* First Report, vol. ii. p. 238.

auses. The majority of houses of the second and third class will ever be so constructed as to be healthful habitations while assessed to e window-tax as at present. I would pass a law to the effect, that if house contained twelve squares on a floor, it should be liable for, say x windows on that floor; but that the owner might make six more indows on that floor if he pleased without any additional charge. I ave thought long and seriously on this subject, and am convinced that e simple alteration I have proposed, by which the revenue need not se a shilling, would confer a greater blessing upon the middle and orking classes, as it regards their habitations, than it would be possible r this Commission to obtain for them in any other way at so cheap a ost. Other means of ameliorating their condition may require local axes or public grants; but here great practical improvements may be ffected by the stroke of a pen."

166. To sum up the whole matter, the protection of the public ealth is a legitimate object of legislative care, because the chief auses which injure the health of communities are capable of being ontrolled by Government, but are not capable of being controlled by ny number of private persons. Though three of the physical agents n which life and health depend, namely, air, water, and light, are rovided by nature in unlimited profusion, so that men have only to ccept them, still it is difficult in towns and cities to obtain a due upply of them and to obtain them in a state of purity. And yet if in he general arrangement of streets and buildings precautions are not taken to render free currents of air accessible, the people are deprived of the main element of existence; if noxious emanations are allowed to accumulate in the air in and around dwellings, the people are poisoned; and if light is excluded from dwellings, the people are rendered wholly incapable of attaining their full strength and vigour. Here then is the province of the legislature, to frame the best general regulations that can be devised for securing the supply and the purity of these elements of life. So with regard to the two other life-sustaining agents, namely, food and temperature, though these, unlike the three first, are not supplied by nature, but are the products of human skill and industry, yet is the interference of the legislature, even with regard to these, to a certain extent not less just and necessary. No government indeed can supply the people with food, nor provide them with the means of generating and sustaining the artificial temperature they

require, that is, with houses, clothing, and fuel; yet Government can, at least, so far interfere with food as to prohibit the sale of unwholesome food, and with houses so far as to prohibit their unsafe, defective, and unhealthy construction. It can do more; it can religiously abstain from offering any kind or degree of obstruction (if it cannot afford help) to the abundant and cheap supply of food, and of the materials for houses, clothing, and fuel. Upon the abundant and cheap supply of these necessaries of life in their purity, the physical welfare of the people depends, and upon their physical welfare depends their intellectual, moral, and religious existence, not to say excellence. The charge of these things is, therefore, not only within the legitimate province of Government, but constitutes one of its ultimate and highest objects.

167. To the Marquess of Normanby belongs the merit of being the first to introduce into Parliament a general measure with a view to carry out some of the most essential of these objects, and it ought to be recorded to the honour of the House of Lords, that they twice passed the measure submitted to them by the then Secretary of State for the Home Department. The Recommendations subsequently proposed by Her Majesty's Commissioners appointed to make further inquiry as to Remedial Measures, appear to your Committee to be signally sound, practical, and complete; and as the Bill, founded on those Recommendations, introduced by the Earl of Lincoln into the House of Commons, will probably be taken as the basis of any sanatory measure, it has appeared to your Committee to be impossible to consider with too much care the provisions of this Bill in the present stage of sanatory legislation.

Sound Provisions of the Bill.

168. From the best attention then which your Committee have been able to give this subject, they are of opinion that the sound provisions of this Bill are the following:—

1. The general enactment, that the supply of water, the sewerage, the drainage, the cleansing, and the paving of towns, including the suburbs, shall all be placed under one and the same authority (§ 5):
2. The appointment of a Government Inspector (*Ibid.*):
3. **The appointment of an Inspector of Nuisances:**
4. **The appointment of Local Boards of Commissioners** for car-

rying out the provisions of the Act in their respective districts (*Ibid.*):

5. The preparation or the local examination of surveys, plans, and estimates, by competent and responsible officers, before any works are undertaken (*Ibid.*):
6. The publication of these surveys, plans, and estimates, with expository Reports for local distribution, in order that the proposed works may be thoroughly canvassed by all parties interested in them before they are commenced (*Ibid.*):
7. The execution and maintenance of all works by contract; the performance of the contracts to be supervised by paid and responsible local officers (*Ibid.*):
8. The appointment in districts of medical officers of health.

Errors and defects of the Bill.

169. The errors and defects of the Bill appear to your Committee o be:—

1. The limitation of the Act to England and Wales, to the exclusion of the Metropolis even of England, and to the total exclusion of Ireland and Scotland, without providing for the immediate preparation of a survey and plan of the metropolis, and a Report as to the special measures applicable to the Metropolis, to Ireland, and to Scotland (§ 8 *et seq.*):
2. The omission to create a central superintending authority in subordination to the executive government, invested with the same sort of powers with reference to the local Boards intrusted with the execution of the details of the Act, that the Poor Law Commissioners have with the Boards of Guardians; instead of this, giving the entire superintendence of the Act to the Secretary of State for the Home Department (§ 12 *et seq.*):
3. The omission to take adequate powers for compelling the Boards of Local Commissioners duly to execute the Act (17):
4. The creation of a new, complex, and needless machinery for electing Boards of Commissioners, instead of adopting the mode of electing Boards of Guardians now in use throughout the Poor Law Unions, which is found in practice to work perfectly well (19):

5. Investing the Boards of Commissioners with powers to execute works, instead of rendering their functions entirely and strictly ministerial and supervising, and neglecting positively to restrict by an express enactment their duties to acts of this class (20 *et seq.*—31 *et seq.*):

6. The omission to prohibit by a sufficiently stringent enactment Boards of Commissioners from commencing any works without having caused plans and estimates to be prepared by their own surveyor, and without having obtained for these plans and estimates the sanction of the Inspector (30 *et seq.*):

7. The omission to secure by sufficiently stringent enactments that all works whatsoever shall be executed only by contract upon open tenders, and shall be maintained in repair for terms of years (37 *et seq.*); and that the contractor shall be bound to undertake any extraordinary works at a fixed remuneration (41):

8. The omission to provide facilities for the formation of public companies for carrying out by contract the provisions of the Act (42 *et seq.*):

9. The omission to make sufficient provision for raising the necessary capital for the execution of large sanatory improvements; namely, by loan raised on the security of a special rate to be levied on the properties in the several localities, the principal and interest to be repaid by annual instalments within a limited number of years (44 *et seq.*):

10. Fixing the cost on owners, whereas it ought to be placed on occupiers (51 *et seq.*):

11. Neglecting to provide in the manner above recommended, that the expense remain a charge upon the several properties, unless the owners prefer to pay the cost in the first instance (45 *et seq.*):

12. Neglecting to make it compulsory on water companies to give the public a constant instead of an intermittent supply, and to deliver it in all cases at as high a pressure as is practicable (56 *et seq.*):

13. Neglecting to make it compulsory on water companies either

to filter the water or to provide a sufficient area of depositing bed (80 *et seq.*):

14. The omission absolutely to forbid the construction of cesspools in all new dwellings, and to provide for the compulsory removal of all existing cesspools as soon as the general introduction of sewers and drains, combined with an adequate supply of water, shall have rendered the universal adoption of the wafer closet apparatus practicable (83 *et seq.*):

15. Neglecting the entire subject of ventilation, one of fundamental importance in a sanatory measure (89 *et seq.*):

16. The omission to give adequate powers to the Commissioners to remove, under the direction of the Inspector and the District Officer of Health, any house or houses which may be so situated as to render a street a cul-de-sac, preventing the possibility of a current of air from passing through it; and, the further omission to give power to the same authorities to raise money for opening thoroughfares, and for the construction and maintenance of public walks (101):

17. The omission to provide for the removal of nuisances arising from manufactories in towns and populous districts (105):

18. The omission to provide for the removal of the smoke nuisance (107 *et seq.*):

19. Neglecting in reference to the medical officer of health to make provision for the performance of his primary and essential duties; namely, the verification of the fact as well as of the cause of death, the correct registration of both, and the personal examination on the spot of the sanatory circumstances under which death takes place (118 *et seq.*):

20. The omission to make any modification in the mode of assessment of the window-duties, though a principle of assessment has been pointed out by the adoption of which the revenue need lose nothing, while great facilities would be afforded for the better construction of dwelling-houses, and for the freer admission to them of light and air (151 *et seq.*).

170. If the provisions enumerated § 168, are passed into a law, and if the errors and omissions pointed out § 169, are corrected and

supplied, this Act will, in the opinion of your Committee, form one of the most comprehensive, efficient, and beneficent statutes ever enacted by any legislature in any age or country. Its direct effect will be the renovation of the physical strength and vigour of the people, and an augmentation of their means of subsistence, first, by increasing and sustaining their working power, and secondly, by diminishing the sum at present expended on sickness, orphanage, and premature decrepitude; and ultimately, a large addition to their longevity: while indirectly but not less certainly it will promote their intellectual, moral, and social improvement. Your Committee, therefore, earnestly request the attention of the members of the Association and of the public generally to the facts and conclusions now stated, and they respectfully submit them to the consideration of the Government and of the Legislature.

46

ON THE

HEALTH OF TOWNS,

AS INFLUENCED BY

DEFECTIVE CLEANSING AND DRAINAGE

AND ON THE APPLICATION OF THE

REFUSE OF TOWNS

TO

AGRICULTURAL PURPOSES.

BEING A LECTURE DELIVERED AT THE RUSSELL INSTITUTION,
MAY 5, 1846.

BY

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Second Edition.

LONDON:
HENRY RENSHAW, 356, STRAND.
1846.

LONDON:
PRINTED BY G. J. PALMER, SAVOY STREET, STRAND.

ADVERTISEMENT TO THE SECOND EDITION.

SINCE the first edition of this Lecture was published, its subject has derived new interest and importance from two events which are well fitted to follow the one upon the other. The one is, the probable repeal of the corn-laws, by which English agriculture is opened to competition, and the other, the reference to a select committee of the House of Commons of the bill of the Metropolitan Sewage Manure Company, and of the general question of the application of the refuse of the metropolis to the purposes of agriculture. The increased importance thus conferred on the subject-matter of the second part of this Lecture has induced the author to exercise much care in its revision, and to make slight alterations in the text, and some additions to the Appendix.

The Lecture was originally printed at the instance of several gentlemen who were present at its delivery. Its object was to promote the cause of sanatory improvement by connecting the health of towns with the important question which has lately engaged so much of public attention; and, especially, to prove that the waste of health and life at present taking place is closely connected with a waste of the raw material of food. It is scarcely necessary to state that the lecture takes a popular rather than a profound view of the subject. Such alterations have been made in it as were rendered necessary by the want of the tables and diagrams by which it was illustrated, and a series of Appendices have been added, which will be found to contain additional illustrations of the leading positions advanced.

LECTURE.

GENTLEMEN,

IN seeking this opportunity of addressing you on the *Health of Towns*, I have been influenced partly by a sense of the great and growing interest which attaches to this subject, and partly, but in a still greater degree, by my own deep conviction of its surpassing importance. It is this conviction which has induced me, on more than one occasion, to offer my services, as a lecturer, to the Health of Towns' Association; and in doing so, as in addressing you this evening, I feel that I am acting in the spirit which has influenced the most distinguished members of my profession, who have ever esteemed it both a duty and a privilege to make known the means by which disease may be prevented, and health preserved; knowing full well, from their own daily experience, how much more is to be effected by the simplest methods of prevention than by the most skilful attempts at cure.

The great and growing interest, which, as I have said, attaches to the subject of the Public Health, and to that of the Health of Towns, as an important constituent part of it, is of comparatively recent origin; for although health has always been justly regarded as the first of earthly blessings, and its preservation as a sacred duty, it has been looked upon rather as an individual concern, than as a matter in which communities and nations have a deep and lasting interest. Hence, though individuals have always shown themselves solicitous for the preservation of their own health, the health of the mass of the people has attracted little attention, and has been rarely made the subject of legislation.

The national indifference to this subject, however, like the equally strange apathy evinced in the matter of education, has lately been replaced by an interest and a zeal more worthy of a great and enlightened people; and the period is evidently fast approaching when the Public Health will take its place among the matters most deserving of the care and attention of the Legislature.

The sanatory movement, of which you must all have witnessed some indications, may be said to date from the publication, in 1842, of the valuable Report of the Poor Law Commissioners on the sanatory condition of the Labouring Population of Great Britain. This was soon followed by the appointment of a commission for inquiring into the health of large towns and populous districts, which issued its first report in the year 1844, followed by the publication of a vast mass of additional evidence, and by some valuable suggestions based upon that evidence. The importance which the government attached to the labours of this commission was evinced by a paragraph in the speech from the throne, at the opening of the last session of Parliament, and still more satisfactorily by the Towns' Drainage Bill, which, with some essential improvements, we may hope soon to see passed into a law.

To complete this short sketch of the rise and progress of the sanatory movement, it is necessary to mention the gratifying fact that in the metropolis and in the principal provincial towns, associations have been formed for the purpose of diffusing a knowledge of the circumstances that injuriously affect the health and lives of their inhabitants, and of the means by which the one may be preserved and the other protected. Nor must I omit to state that the working classes, who are the great sufferers by the neglect of sanatory measures, have formed among their own body an association for the same laudable purpose.

But a still more convincing, and, if possible, more gratifying, proof of the hold which this great movement has taken upon the public mind, is to be found in the fact that a young nobleman, Lord Ebrington, not satisfied with the honour which waits on rank, but determined, in the true spirit of nobility, to earn his own independent claim to the respect and gratitude of the public, has lent a new grace and dignity to the office of the lecturer, by becoming a public teacher of the great truths revealed by the labours of the Health of Towns' Commission. I, for one, must confess that I am not indifferent to the companionship into which this act of his lordship has brought me, and that I appear here this evening with more satisfaction, when I reflect that in the useful labours of public teaching, I have his countenance and example.

I have thus briefly alluded to the leading particulars of the sanatory movement with a view of justifying my appearance among you this evening, on the score of the interest which my subject is calculated to excite.

But the labours of the Health of Towns' Commission prosecuted in the spirit of Mr. Chadwick's valuable report, have given an unusual interest to the subject of the health of towns, by demonstrating that public health is a branch of national economy, that unnecessary sickness and premature death impeach the prudence, no less than the humanity of the nation which suffers them, and that sanatory measures are, in every sense, and in every way, a gain.

Among the most striking illustrations of this great and important truth, the most remarkable, perhaps, is the value which has been assigned to those refuse matters of towns, which, when allowed to accumulate within their precincts, impair the health of their inhabitants, and give rise to severe and fatal diseases.

Nor is it possible to overlook the additional interest which attaches to this part of the sanatory question in consequence of the great and comprehensive measure of commercial reform which has been so lately submitted to the legislature by Sir Robert Peel. This is not the place nor the occasion for discussing the merits of this measure; but I may be permitted to allude to the apprehension existing among the owners and cultivators of land so far as to observe that the value attached to the refuse of towns, coupled with the proved possibility of applying it to the land with an economy at present unknown, and, by the great majority of persons not even imagined, is calculated to remove such apprehensions, and to place beyond the reach of doubt the power of England to compete in agriculture as in manufactures with the most favoured nations of the world.

To establish this position is one of the objects of this evening's lecture, in the course of which I hope to be able to show that the principal cause of the unhealthiness of towns is to be found in the presence of those very substances which, if applied to the land, would endue it with inexhaustible fertility, that health and plenty are thus indissolubly united, and that we have it in our power, at the same time that we are effecting a great economy, to confer an immense benefit on every class of the community.

These leading statements resolve themselves into a series of subordinate propositions, which may be briefly stated thus. 1. That towns are unhealthy; 2. That one of the leading causes of their unhealthiness is defective cleansing and drainage; and 3. That the refuse of towns, which, when allowed to accumulate within their precincts, impairs the health of their inhabitants, and gives rise to severe and fatal diseases, may be most advantageously applied to agricultural purposes.

I shall address myself to each of these propositions in turn. And first, as to the fact that towns are unhealthy.

This fact stands in need of no laboured demonstration. All the inhabitants of towns are conscious of it, and practically admit its truth. But the degree of that unhealthiness is not quite so generally known; I must, therefore, display it by the aid of figures. For this purpose I avail myself of one of the reports of the Registrar General, from which it appears that if we compare one million of the inhabitants of large towns with the same number of the inhabitants of rural districts, the inhabitants of towns lose nearly 8000 more every year than the inhabitants of the country. The exact number is 7,773.

Another proof of the unhealthy condition of our large towns is to be found in the low average duration of life of their inhabitants. For instance, the mean duration of life in Surrey is 45 years; it is 37 for London, and only 26 for Liverpool. The inhabitants of the metropolis, therefore, taking one with another, when compared with those of Surrey, lose 8 years of their lives, and the inhabitants of Liverpool 19 years!

The unhealthiness of large towns, therefore, is proved both by the excessive mortality, and by the low average age at death of their inhabitants.

It may be interesting to compare the mortality of some of our principal towns.*

Taking the average number of deaths for the three years 1840—42, and comparing that number with the population, as ascertained by the census of 1841, we obtain the following results;—Liverpool loses every year 35 in the thousand; Manchester 32; Bristol 31; Hull and Leicester 30; Preston 29; and so on until we come, step by step, to Halifax and Kidderminster, which have a mortality of 21 in the thousand. Several towns of considerable size present the still more favourable rate of 20 in the thousand, 2 per cent, or 1 in 50.

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* See Appendix A.

The mortality of our large towns, therefore, varies from 35 in the 1000—that of unhappy Liverpool, to 20 in the 1000—that of several populous towns. The mortality of England is 22 in the 1000, or 1 in 45.

The most obvious inference to be drawn from this statement is that, as a general rule, towns, and especially large towns, are extremely unhealthy; which is the first subordinate proposition that I undertook to establish.

A very important inquiry which connects itself closely with this proposition, and forms a necessary link in my chain of reasoning, is this, *are all parts of our large towns equally unhealthy?*

A single fact will suffice to furnish an answer in the negative to this question. In one of the reports of the Registrar General, the several districts of the metropolis are divided into three groups of ten districts each, under the titles of the *healthiest*, the *medium*, and the *unhealthiest* districts.

The ten *healthiest* districts, with an allowance of 202 square yards of space to each person, have a mortality of 1 in 49.

The ten *medium* districts, with about half the space namely, 102 square yards, lose 1 in 41.

While the ten *unhealthiest*, with the meagre allowance of 32 square yards to each inhabitant, have a mortality of 1 in 36.

From this table we learn two facts, first, that some parts of large towns are much more fatal to life than others, (an answer to our question,) and secondly, that the mortality increases with over-crowding, attaining its highest point in the most densely peopled districts.

Now, I need not tell you that these crowded districts are the abodes of the labouring classes and of the poor—the districts of narrow lanes, blind courts, and dark cellars—the chosen resorts of filth and fever, of every physical and moral abomination, of all the barbarism that hides itself in the midst of the splendours and triumphs of civilization. A description of the worst of these places could not fail to excite emotions of disgust and horror. They combine in a frightful degree all that is most offensive to the senses, most revolting to the feelings, most injurious to health, most fatal to morals. In one word, they present in their most hideous and revolting aspect the inevitable consequences of the cruel system of *laissez faire*,—a system which is the shame and reproach of England, and which, if persevered in, will one day be her ruin.

I might produce, if time permitted, a vast number of illustrations of the great truth, that, as things now are, the poorest and most densely peopled districts of our large towns are the seats of an excessive mortality. But I must proceed. I will, however, merely state, *en passant*, that Liverpool, which is the most densely peopled town in England, is also the unhealthiest, and that Manchester, which emulates it in this respect, as well as in the large population of cellar-dwellings and blind courts which it contains, comes next in order;

while Birmingham, which allows its inhabitants more room to breathe, has no cellar-dwellings, and few blind courts, presents a far more favourable rate of mortality.

The towns and parts of towns, then, which are most densely peopled, are also most unhealthy; and I have already stated that the most crowded districts of our large towns are those which are inhabited by the labouring classes and the poor; so that I might with equal propriety have affirmed that the districts inhabited by the labouring class and the poor are extremely unhealthy. Those whose professional avocations, or motives of charity lead them to visit the streets and houses of the worst parts of the metropolis will have no hesitation in admitting the truth of this statement. But even they are probably not quite prepared to hear of such a fearful sacrifice and curtailment of life as have been shown to exist among the class inhabiting these districts. Thus, to take a single metropolitan parish—that of St. Giles', and St. George's Bloomsbury, —while the gentry who inhabit the open squares and broad streets, live on an average forty years, the working class, who inhabit narrow lanes, blind courts, and dark cellars, live only seventeen years; that is to say, they lose, one with another, just twenty-three years of their lives. In Shoreditch, the loss amounts to twenty-eight years. I might multiply examples of this fact to almost any extent, but I think that I have given a sufficient answer to my question, and have proved what is by no means unimportant for my present purpose, that sickness and death press most heavily on the crowded districts inhabited by the labouring classes and the poor.

I now, therefore, proceed to prove my second position,—*that one of the leading causes of the unhealthiness of towns is defective cleansing and drainage*; and I shall do this by means of a single striking and familiar example.

The Rev. J. Clay, of Preston, in his evidence before the Health Commission, institutes a comparison between three classes of streets in that city, which he characterizes as "*well-conditioned*," "*moderately-conditioned*," and "*ill-conditioned*;" or, in other words, *well-cleansed and drained*, *moderately cleansed and drained*, and *badly cleansed and drained.* To these he adds a fourth class, consisting of certain courts and alleys selected from the ill-conditioned quarters, as being the very worst among the bad. The results of this comparison are very striking. In the *well-conditioned streets* the mortality among children under one year old, is 15 in the 100; in *moderately-conditioned streets*, 21 in the 100; in *ill-conditioned streets* 38 in the 100; and in the *worst-conditioned streets* 44 in the 100, being, as nearly as possible, three times the mortality of well-conditioned streets.

I might adduce similar evidence of the fatal effects of deficient cleansing and drainage from the evidence laid before the Health Commission by competent and skilful observers in Liverpool, Manchester, Nottingham, Leicester, and the chief centres of manufacturing and commercial activity. But I prefer to strengthen my position by adducing the beneficial results which have followed an improved system. Mr. Holland of Manchester states that in 20 streets in Chorlton-on-Medlock, the mortality fell from 110 to 89 per annum, after, and no doubt principally in consequence of, the streets being properly paved and drained. Mr. Gardiner and Mr. Noble have confirmed the result by showing that in certain streets in St. George's district, Manchester, the deaths in 1838-9, amounted to 495; but that in 1841-2, after the streets were paved and sewered, the deaths were only 432, being a diminution of 53, or about one-eighth. In a district in Ancoats, a diminution of 40 deaths out of 270, or about one-seventh, followed a similar improvement.

But a still more striking illustration of the same fact may be found nearer home. It is contained in Mr. Liddle's evidence before the Health Commission.

"Windmill-court, in Rosemary Lane, was one of the most unhealthy in my district. It was unpaved and filthy, and with stagnant water before the houses. I used to visit it sometimes two or three times a day for fever cases. About twelve months ago it was flagged; it was well supplied with water from a large cast-iron tank, which enables the inhabitants to have a constant supply instead of an intermittent one, on three days a-week. The court is regularly washed down twice a-week, and the drains are so laid that all the water passes through the privy and carries off the soil, which was formerly a most foul nuisance, and a constant expense to the landlord. In the seven months ending March, 1843, I attended 41 new cases of sickness in that court; in the last four or five months, I have had but two cases."

I need scarcely add that these improvements *paid* the landlord.

Having now proved, by two opposite modes of illustration, that defective cleansing and drainage are among the leading causes of the unhealthiness of large towns, let us next inquire a little more narrowly into the effects which they produce. What are the diseases occasioned by this neglected state of the poorer districts of our large towns?

In addition to a general impairment of health and unusual liability to disease, there is one particular class of disorders which is always to be found in these neglected places. I mean the class of contagious disorders. History teaches us that pestilence has always haunted scenes of filth. The plague, the black death, the camp, jail, and ship fevers, the cholera,—all have made these scenes their favourite resort, and typhus fever, our modern pestilence, forms no exception to the rule. I shall content myself with a single authority in support of this statement. It is that of the experienced physician of the Fever Hospital, Dr. Southwood Smith, who has taken so active a part in the great sanatory movement.

"The records of the London Fever Hospital," he says, "prove indubitably that there are certain localities in the metropolis and its vicinity which are the constant seats of fever, from which this disease is never absent, though it may prevail less extensively, and be less severe in some years, and even in some seasons of the same year, than in others." "In former years, in some localities there was not a single house in which fever had not prevailed, and in some cases not a single room in a single house in which there had not been fever." "The districts in which fever prevails are as familiar to the physicians of the Fever Hospital as their own names."

Now, what is the character of these districts? In answer to this question hear Dr. Southwood Smith again.

"In every district in which fever returns frequently and prevails extensively, there is uniformly bad sewerage, a bad supply of water, a bad supply of scavengers, and a consequent accumulation of filth; and I have observed this to be so uniformly and generally the case, that I have been accustomed to express the fact in this way:—if you trace down the fever districts on a map, and then compare that map with the map of the Commissioners of Sewers, you will find that wherever the Commissioners of Sewers have not been, there fever is prevalent, and, on the contrary, whereever they have been, there fever is comparatively absent."

These are strong expressions, but I believe not stronger than the author of them is warranted in using.

Some idea may be formed of the evils which our negligence in the matter of sewerage and drainage inflicts, when I tell you that the annual deaths from typhus fever amount to 16,000, and the attacks of this loathsome disease to between 150,000 and 200,000!

Of the *expense* which this disease entails upon the community I shall have an opportunity in the course of the evening of giving you a very striking example.

I have now, as I trust, proved to your satisfaction, —1, *That towns are unhealthy*; and 2, *That one of the leading causes of their unhealthiness is defective cleansing and sewerage.* It now only remains that I prove to you that this fruitful cause of disease may be made a source of fertility,—that it is within our power to minister to the health of our towns and the fruitfulness of the surrounding country by one and the same means.

I shall do this by establishing the two following subordinate propositions.

1. That the refuse matters of our towns are rich in the elements of production.

2. That these refuse matters may be conveyed and applied to the land with facility and economy.

And, *first*, as to the value of the refuse matters of our towns. I shall prove this by *à priori* arguments; by chemical analysis; and by actual experiment.

At present, as you are well aware, the only refuse matters of our towns which are employed as manure, (and that to a very limited extent,) are the sweepings of streets, and the contributions of the ash-pit and the cess-pool. The valuable contents of our sewers are allowed to run to waste. It is to these, however, that I wish to direct your attention; and I am anxious to prove, anterior to any chemical analysis, that they must needs abound in all the elements of the food of plants.

In the first place, wherever a proper system of house-drainage prevails, the valuable excreta of the human frame containing the ashes of all the food that has been consumed by the inhabitants, find their way into the sewers. Experience has proved that these excreta, but especially the urine, are among the most effective of our manures; and that they far exceed in value the products of the farm-yard and all solid manures, not even excepting guano. It is well known too, that in China, and in those parts of the continent of Europe where agriculture is most skilfully practised, great store is set by this fertilizing liquid.

To this, the most important constituent of sewer-water, we must add, as also derived from house-drainage, the alkalies, potash and soda, which are so largely used for household purposes, in the form of pearl-ash, soap, and common salt. These alkalies form, as is well known, very important elements of the food and structure of plants.

Such, then, are the valuable matters poured into our sewers, wherever a proper system of house-drainage is in force.

Large contributions are also made to the same fertilizing liquid by the refuse of slaughter-houses, markets, and manufactories. The animals fed and worked in our large towns also enrich the sewer-water, by that portion of their excreta which finds its way, in a more or less circuitous manner, into the sewers. Then we must not forget that our granite roads, rubbed down by constant traffic, furnish a large and valuable supply of silica, alumina, and iron, in a state of minute division, and therefore, ready to become the food of plants.

I have yet to mention the large quantity of soot rich in ammonia and sulphurous acid, which, issuing from our chimneys, is brought down by every shower, and conveyed direct into the sewers, forming a not unimportant addition to their contents.

I should not have entered so much into detail with regard to the contents of our sewers; but that I thought it of great importance to prove by every possible means the value of the fertilizing liquid which we are now so ignorantly wasting.

Having now proved the value of sewer-water by tracing the elements of which it consists, and the several sources from which it is derived, I proceed to prove its value by *actual analysis*. Not that any analysis can add much to the conviction of the value of sewer-water, which the most careless consideration of the sources from which it is obtained must produce. All the constituents of the food consumed by human beings, with the exception of the water and gaseous matters which exhale from the lungs and skin, and which go to swell the immense ocean of aërial manure, must find their way into the sewers; and it is obvious that these substances, with the straw and other unconsumed produce of our fields, form the complement of the water, carbonic acid and ammonia which are floating in the atmosphere. All the other substances which I have named are additions to these, the most valuable constituents of sewer-water.

This statement is fully borne out by actual analysis of sewer-water. I will take the Metropolis as the town in which we have the greatest interest, and avoiding all minor details will present you with the results of a calculation which I have made. The ordinary daily amount of sewage discharged is 9,502,720 cubic feet, or 57,016,320 gallons; and each gallon contains, on a moderate computation, 50 grains of saline matters, constituting the essential elements of plants. I leave out of consideration the valuable matters in suspension. The saline matters removed from 100 acres of ground (50 wheat and barley, and 50 green crops), is 6437 lbs. A calculation based on these data gives 2,104,590, as the number of acres which could be supplied annually with the materials of their present amount of production; being at the rate of upwards of an acre to each inhabitant.

An analysis of the water of the River Medlock, which may be said to constitute the open sewer of a considerable part of the town of Manchester, gives a similar result.

If we take the nitrogen as our test of the quantity of land which could be supplied with the elements of wheat (all the other elements are in much larger proportion) no less than 93,440 acres, or little short of 100,000 acres, of wheat land could be manured by the sewer-water of one of the worst drained towns in England. Now, the inhabitants of the part of Manchester drained by the Medlock fall short of 100,000, so that it follows that in a town in which house-drainage is notoriously imperfect, there is every

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* See Appendix B.

year poured into the river for each inhabitant a quantity of fertilizing matter sufficient to supply an acre of wheat.

Even with its present imperfect system of house-drainage, the Medlock contains a sufficient quantity of *phosphoric acid* to supply 95,000 acres of wheat, 184,000 acres of clover, 258,000 acres of potatoes, or 280,000 acres of oats. The *silica* (flint) in solution is sufficient to supply 50,000 acres of wheat. And there can be no reasonable doubt that taking one crop with another, for every inhabitant of a large town there is at present thrown into our rivers, and carried out to sea, fertilizing matter sufficient to crown an acre of land with plenty.

In both these estimates I am assuming the present average produce of the soil; but it is confidently anticipated that under the use of liquid manure that produce would be doubled or trebled, and that consequently the area supplied would be diminished in a corresponding proportion.

But the most satisfactory and convincing proof of the value of the refuse of towns is afforded by the results of its actual application to the purposes of agriculture.

I shall give you a single example of this in the case of Edinburgh, in the immediate neighbourhood of which city the sewer-water has, for a long time, been in extensive use. It appears that by irrigation with sewer-water, lands which were originally worth 30*s*. or 40*s*. to £6 an acre now fetch from £30 to £40 an acre, that poor sandy land on the sea-shore which might be worth 2*s*. 6*d*. an acre now lets at an annual rent of from £15 to £20, and that part of the Earl of Moray's meadow has yielded as high a rent as £57 per acre. So enormous is the increase of value conferred by this fertilizing liquid, that the parties interested in 300 acres of land estimate the compensation that would induce them to discontinue the use of the sewer-water at £150,000. Similar results have been obtained at Milan, and in all other places where liquid manure has been brought into use.*

I have now shown by *à priori* argument, by actual analysis, and by experiment, the great value of the refuse matter of our towns. I next proceed to show *that this refuse matter can be easily and cheaply conveyed and applied to the land.*

The water as it flows from the sewers is a dirty liquid holding a large quantity of valuable salts in solution, and a variable proportion of less valuable matters in suspension. If, after removing the lighter substances which float on the surface, the heavier matters held in suspension are allowed to subside, which they do in the space of two or three hours, the supernatant liquid, though still containing the most valuable elements of plants, will admit of being dealt with as if it were common water. Now we all know from the experience of Water Companies how easily and economically large quantities of water can be transmitted to great distances by machinery. If this plan were adopted, it is laid down by high authority, that while the cost of the cartage of solid manure would amount, under the most favourable circumstances, to 4*s*.

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* See Appendix C.

per ton, the cost of conveying sewer-water by machinery would be only 2½*d.* a ton. According to another high authority, while the distribution in the solid form costs about £3, that in the liquid form costs only 6*s.** It has also been experimentally proved that the sewer-water admits not merely of being conveyed to the land thus economically, but that it can be easily and cheaply distributed over the land by means of a hose.†

It would appear from the estimate which I have just adduced, that the cost of conveying the sewer-water by pipes and distributing it by hose would amount to from one-tenth to one-twentieth of the expense entailed by cartage and distribution in the ordinary manner.

In proof of the economy of this mode of distribution by machinery and pipes, I may mention that not long since a plan was seriously proposed of dissolving the guano as it arrived at our sea-ports, and distributing it by means of pipes over the country.

But this distribution by machinery and pipes has been actually put to the test of experiment on a farm of 300 acres in the neighbourhood of Glasgow, where an intelligent and spirited agriculturist has found it worth his while to lay down pipes throughout his estate, at a cost of 30*s.* an acre, and to distribute the liquid manure by a steam engine at one end and a hose at the other. The steam engine was already in use for other purposes.

I may mention that the pipes which are thus made subservient to the distribution of the most valuable ma-

* See Appendix D.

† See Appendix E.

nure in existence may also be employed for the purposes of irrigation in seasons of drought, and I have it on the highest authority that in a single dry summer, the cost of the pipes would be defrayed by the water which they would convey.

You will observe that I have assumed without hesitation that there is but one reasonable way of dealing with this valuable manure, namely, to convey and distribute it in the liquid form, as clean water is now conveyed to our towns.

Common sense, confirmed by ample experience, points out the liquid form as that which is in every respect the most convenient as well as the most effective. The water-closet, which, even in the houses of the poor, is fast superseding the barbarous and costly cesspool, is obviously the cheapest and most efficient means of removing the offensive refuse of our houses; the sewer is in every respect an immense improvement upon the nightman's cart; the proposed conveyance of its contents by machinery is a still more obvious step in advance of the tardy and expensive carriage in the solid form; while the distribution by hose completes the chain of wholesome and economical expedients. Add to these considerations the employment of the same machinery for irrigation in seasons of drought, and the system is complete.

One might almost imagine that under the guise of a fable the wisdom of antiquity had designed to shadow forth the excellent uses and surpassing efficacy of water as a scavenger. The strength of a Hercules could not contend successfully with the filth of the neglected stable, till he had called in to his assistance the irresistible might of water. So, in our heroic days, that which an army of scavengers cannot effect, rivers of water conducted by the strong arm of machinery shall accomplish with ease. The worse than Augean filth of our large towns shall be swept away, and with it the pestilence that lurks in scenes of filth; and as if to make amends for the fearful evils which it has inflicted, the cruel parent of disease shall become the source of overflowing plenty, thus affording to future generations a tardy compensation for the evils inflicted on the past. So much for water as a scavenger. I must not forget that my present business is to consider it as a vehicle for manure, and that I am pledged to show that the liquid form is that in which it may be best conveyed and applied to the land.

I presume that it is quite unnecessary to adduce any proof that the food of plants must be presented to them in a liquid form. It is well known how much the success of all solid manures depends upon the accident of their application being followed by rain, and how completely the best of them will fail in seasons of drought. The extraordinary efficacy of irrigation with mere river water is another proof of the superiority of liquid manure. The small quantity of matter held in solution in the water, applied to the roots of the plant in this manageable form, yields better results than large quantities of solid manure.

But it would be a mere waste of time to enlarge upon this point. The advantage of applying manure dissolved or suspended in water may be taken for granted; and this being the case, the whole question is virtually set at rest. There remains, indeed, that part of the question which relates to the machinery itself, a question into which it would be presumption in me to enter. I cannot, however, allow myself to suppose that the English engineer will encounter any difficulty in combining in one harmonious system all the obvious requisites for the distribution of the sewer-water, viz., economy, efficiency, and the avoidance of all nuisance in the neighbourhood of his works. To have any misgiving upon this point would be to call in question the engineering skill which is every day triumphing over the greatest difficulties.

In this application of machinery to agriculture it must be obvious that nations abounding in large towns, and having a small proportion of waste land, must possess an immense advantage over thinly peopled and newly settled countries; for while their supply of manure is larger, the distance to be traversed by pipes is less. Adopt this system, and the fear of foreign competition will prove as unfounded as it is unworthy of Englishmen.

I have neither time nor inclination to notice the alternative of continuing to waste all the liquid refuse of our towns, or of employing only the solid deposits, deprived of the most valuable of their constituents.*

I should be grieved, indeed, to think that this dream of sanatory and agricultural improvement was doomed not to meet with its fulfilment. I trust that the commercial enterprize of the people, under the wise control and direction of the Government, will soon put the value of the liquid refuse of our towns, and the proposed methods of conveying and distributing it to the test of experiment; that we may no longer be outraged by this two-fold sacrifice of human life and of the elements of abundance.

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* See Appendix F.

I regret that the narrow limits of a lecture do not permit me to enter more minutely into this part of my subject. Indeed, there is not a single proposition which I have put forward that I would not willingly have illustrated by additional facts, arguments, and authorities. But, in touching thus lightly upon matters of so much importance, I have been partly influenced by a desire to reserve a small space for a broad and comprehensive view of my subject as a great question of national economy. I am anxious to take a pounds-shillings-and-pence-view of the matter. Not that health is not far too precious, and life far too sacred to be weighed against gold and silver. They are both beyond all price. Nevertheless, pounds, shillings, and pence may be fairly employed in illustration of the value of health and life; and they form a just measure of the waste of the valuable material which, as I have shown, exercises so baneful an influence upon both.

I stated, at the beginning of this lecture, that the deaths occurring every year in a million inhabitants of large towns, exceed the deaths occurring in the same number of inhabitants of rural districts by nearly 8000. Now, if we estimate the population of our large towns at 4,000,000, we shall certainly be very much below the mark; but even this estimate will give an annual excess of deaths of upwards of 30,000.

But a more satisfactory mode of calculating the mortality of our large towns is to take these towns one by one, to ascertain the sum total of the deaths that occur in them year by year, and to compare that total with a healthy standard. I have made such a comparison in the case of thirty-six of our large towns.

The population of these towns in the year 1841 was 2,791,835, and the excess of deaths on the average of three years, 1840, 1841, and 1842, above the healthy standard of 2 per cent. was, 20,101. The population of the metropolis at the period of the census was 1,873,817, and the average excess of deaths above 2 per cent. for the same three years was 8,404. If these thirty-six towns are added to the metropolis, the population amounts to 4,665,652, and the excess of deaths above 2 per cent. to 28,505.*

But there are several large towns not included in this calculation which also suffer from a very high mortality, and if they were added, the total excess of deaths would be raised to considerably more than 30,000.

This number of 30,000 deaths, large as it may appear, is, however, less than the annual waste of life occurring in England and Wales; for assuming, as before, that the annual mortality of England and Wales admits of being reduced to 1 in 50 instead of its present rate of 1 in 45, we should have an annual saving of no less than 35,000 lives, and in the United Kingdom, on the supposition that the mortality in Scotland and Ireland is only equal to that of England and Wales, (it is in fact much greater,) there would be an annual saving of upwards of 60,000 lives.

The assumption that the mortality of our large towns, and *à fortiori* of the kingdom at large, may be reduced to 1 in 50, rests upon the best possible basis, namely, the fact that, in the year 1841, there were no less than 37 towns, some of them of considerable size, in which the mortality did not exceed that amount. There is, therefore, the very best ground for believing that the lives annually sacrificed by a neglect of sanatory measures do not fall short of the appalling number of 35,000 in England and Wales, and 60,000 in the United Kingdom. But such a waste of life pre-supposes a proportionate waste of health—a proportionate amount of unnecessary sickness. It is not easy to ascertain the exact relation which the one bears to the other, but if we take the estimate of Dr. Lyon Playfair, that for every unnecessary death there are 28 cases of unnecessary sickness, there will be every year in England and Wales one million of cases, and in the United Kingdom 1¾ million of cases of unnecessary sickness.

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* Appendix A.

If you find it difficult to realise so enormous a waste of health and life, you have only to imagine a town of 35,000 or 60,000 inhabitants swept away every year from the face of the earth, over and above those who would die in the course of nature, if sanatory measures were in universal operation. To form a vivid idea of the amount of unnecessary sickness in the United Kingdom, you must imagine that in a city of the size of this metropolis, every man woman and child it contains, is the subject of one attack of sickness every year, over and above the sickness which would occur in the course of nature under a wise system of preventive measures. Such being the sacrifice of health and life which annually takes place under our present system of neglect, let us endeavour to estimate it by the aid of pounds, shillings, and pence; and, as I have stated that the disease which has been most clearly traced to the filthy state of our towns, and the want of efficient cleansing and sewerage, is typhus fever, let us begin with this.

There is scarcely, as I think, a more striking or suggestive passage in the English language than the following:

"The Bethnal Green and Whitechapel Unions" (I quote from the evidence of Dr. Southwood Smith) "incurred an extra expense for fever cases for the quarter ending Lady-day, 1838, the one of £216 19*s.*, the other of £400, making a total of £619 19*s.*, and being at the rate of £2,467. 16*s.* a year," "and of the total number who received parochial relief in most of the districts, a very large proportion received it in consesequence of their being ill with fever; but in one district, namely, St. George's, Southwark, out of 1,467 persons who received parochial relief, 1,276—that is, the whole number, with the exception of 191, are reported to have been ill with fever."

If such is the cost of one disease alone, in a single parish or district, what must be the expense entailed by 35,000 unnecessary deaths, with the corresponding number of unnecessary attacks of sickness. In the evidence laid before the Health Commission will be found one or two attempts to solve this grave question. Dr. Lyon Playfair, for instance, has estimated the loss and cost of all the preventable sickness and death occurring annually at Manchester, at very nearly 1,000,000 sterling, and Mr. Hawksley states the loss for Nottingham at 300,000. Taking Dr. Lyon Playfair's estimate, but without pledging myself for its accuracy, (though I may state that it is made with great care,) the annual loss and cost for the metropolis would greatly exceed two millions and a half; for England and Wales, it would fall little short of eleven millions; and for the United Kingdom it would be nearly twenty millions.*

There is something perfectly appalling in these figures, and our first feeling in regard to them is naturally one of incredulity. But a little reflection will convince us that they are not the gross exaggerations they may at first appear to be. If we call for the items of the account, and cast our eye over them we shall probably be satisfied with its moderation. Sickness entails loss of wages, medical attendance, nursing, and expensive diet; death, funeral expenses, and the support of widows and orphans. All these are costly, and the expense when multiplied by thousands and tens of thousands soon swells to millions.

When too we reflect on the large sums to which the taxes of this country amount every year; on the interest of the national debt; and on that huge voluntary tax which the people of England impose upon themselves in the shape of spirituous liquors and tobacco; we begin to think it is quite possible that unnecessary disease and death may also be very costly, and that the "fever-tax" may be the heaviest of all our burdens.

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* See Appendix G.

I must now endeavour to estimate the other branch of national extravagance which I have brought under your notice—to fix a value on the manure which we are annually throwing into the sea.

I shall say nothing of the liquid manure which, as I have been given to understand, is suffered to drain away into the ditches, thence into the rivers, and from them into the sea, from fully one half of all the farmsteads of England;* I will speak merely of the unappropriated refuse of large towns.

In Flanders, where manure is carefully collected, instead of being, as here, suffered to run to waste, the excreta of an adult are valued at £1.17*s.* Considering the enormous additions made to this manure in our towns, it will not be thought unreasonable to estimate the value of that part of the refuse which now runs to waste at £2 per head of the population; and supposing that in England and Wales, the towns which are guilty of this extravagance, contain in all only 5,000,000, inhabitants, we shall have an annual waste of at least ten millions of money.

I am now speaking of the gross value of town-manure, and not of the profit which it would yield; for there is no commodity of which the value is more dependent upon the expense of conveyance and distribution than manure. Thus, manure, which on the field is worth 10 shillings a load, may have fetched in the place from which it was brought, only one shilling, or eighteen pence, the difference being the expense of cartage and distribution. But, in the case of liquid manure, the cost of conveyance and application would be so small, as to increase the relative value of the manure itself, and to yield a large profit on the capital employed. This profit has been variously estimated at from 12 to 15 per cent.

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* Appendix H.

Hence, after all the cost of its application to the land has been defrayed, the refuse of towns which now runs to waste, would have a high money value—a value probably far exceeding, one year with another, that of all the corn and manure which we import.*

If this estimate were extended to the whole of the United Kingdom, it seems highly probable that the value of town-manure annually wasted would be equal to the loss and cost entailed upon the nation by premature death and unnecessary sickness. According to this supposition, which does not appear unreasonable, the total annual waste from these two causes would be about 40,000,000*l.*!

Such, then, are rude, but I believe by no means exaggerated estimates of the twofold waste of health and life, on the one hand, and of the most valuable means of production, on the other, of which England is at present guilty, and it becomes a very serious question whether such extravagance can be persisted in without entailing the most alarming consequences. Our neglect of sanatory measures is obviously chargeable with no inconsiderable part of the heavy and increasing burden of the poor-laws, which, though their ostensible object be the relief of destitution and suffering, must tend to occasion both by withdrawing several millions a-year from the labour-fund, which fund would probably effect much more towards the prevention of poverty than the best devised system of poor-laws can possibly do to relieve it. Sanatory measures would have all the certainty which attaches to measures of prevention, while the poor-laws are open to all the objections and abuses which attach inseparably to the amiable but inefficient substitute for justice—charity.

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* See Appendix I.

Nor let us flatter ourselves that with our increasing population we can afford these annual sacrifices of life. Even admitting that these victims of neglect tend to relieve our redundant population (a theory which is now exploded, for it has been shown that fevers and consumptions instead of diminishing our numbers, tend only to multiply widows and orphans, and to substitute dependent for independent and productive citizens)—admitting, I say, that these victims of neglect were a relief to our redundant population, is there any one, I would ask, so infatuated as to think a large population an evil? If the dogma of Malthus, that population always tends to increase faster than the means of subsistence, were true, then a large population would be an unmitigated evil. But whatever the history of past times may seem to teach us, whatever our own observation may appear to suggest, of this we may rest assured, that neither history nor experience can suffice to establish the tendency in question. So perfect is the mutual dependence of the animal and vegetable kingdoms, that the increase of the one must lead inevitably to the increase of the other, provided always,—and here is the hidden stumbling block of the school of Malthus—provided always, that the land receives back again that which has been removed from it in the shape of food. If, instead of restoring to the land all that we have taken from it, we perversely cast it into the sea, we bring about that exceptional state of things which Malthus, in his ignorance, regarded as the rule of the world, a part of the original design of Providence.

A very slight alteration of the favourite dogma, *population tends to increase faster than food*, will convert a dangerous fallacy into an important and useful truth. If, instead of asserting that *population has a tendency to increase faster than food*, we say *population tends to increase faster than human skill and economy applied to the cultivation of the soil*, we substitute a motive to exertion for one of the most depressing and paralyzing theories which the wit of man ever yet devised.

A large population is an essential element of a nation's greatness. England could not have attained to her present height of prosperity and power without it, nor can she hope to keep her proud place among the nations unless she fosters and encourages to the utmost the increase of her numbers. But a mere increase of numbers without a corresponding increase of wealth, would be an addition to our burdens; not an accession of strength. Wealth can only be made to keep pace with numbers by the exercise of economy—economy of health and life, economy of time, economy of all the means of production. We must contrive, above all things, to economise manure, which is the raw material of food. If we persist in wasting that which we have at hand, we must soon exhaust all foreign supplies, and then we must be reduced, whatever may be our laws regarding the importation of corn, to that dependence on foreigners, which those whose want of economy and want of skill have brought about the necessity, inveigh against as the greatest evil that could befal us. An abundance of food lies at the root of all prosperity; for it is not till the imperious wants of nature are satisfied, that the artificial wants which civilize and exalt mankind spring into existence. The money which each man earns over and above that which is necessary for his sustenance, is the fund which purchases clothing, decent shelter, books, pictures, and all the instruments of improvement and refinement; and the creation of all these things supplies, in its turn, the materials of a prosperous trade and an extended commerce. Hence the immense importance of a skilful and economical system of agriculture—hence the imperative necessity for the exercise of a rigid economy of all the means of production—hence the promised value of the commercial reform which shall substitute for the paralyzing effects of protection the wholesome stimulus of competition.

It is impossible to view the position which England has attained without a lively apprehension. A vast colonial empire can only be retained by a decided naval supremacy, and naval supremacy pre-supposes commercial superiority; commercial superiority, in its turn, is based upon a large and cheap production of exchangeable commodities; and a large and cheap production must ever find its best support in a large and wealthy home population; in other words, in a population having a large surplus of means over and above those which are necessary for the supply of the first imperious want of nature—food. To obtain a large industrial population—a population having a due proportion of adult labourers—we must preserve health and protect life by sound and comprehensive sanatory measures; to insure an ample supply of food, we must turn our own domestic resources to account. In both these respects England is highly favoured—her children naturally strong and robust, display every quality which ensures success to individuals or to nations—skill, energy, perseverance, courage, self-dependence—her climate, with all its disadvantages, being remote from the two extremes of heat and cold, is in the highest degree favourable to successful agriculture; her population large in proportion to the space they occupy, yield in abundance the raw material of food; and her towns, with their constant traffic and extensive manufacturing operations, are so many mechanical and chemical laboratories for rubbing down and preparing from the substances dug from the bowels of the earth, or reclaimed from the sea, the elements of the food of plants. These huge manufactories and storehouses of manure are as yet notorious chiefly for their fatal effects on health and life; but the time is near at hand when they shall be regarded in their true light, as the destined agents of a perfect revolution in agriculture, the centres from which a healthy and prosperous population shall distribute, through the length and breadth of the land, the elements of abundance.

The machinery which has hitherto been employed only in the service of the manufacturer, or in effecting the speedy and economical transport of men and merchandize, shall for the first time be devoted to the purposes of agriculture; and the very same means by which we shall henceforth be secured against the recurrence of drought, will be employed to reconcile abundance and cheapness of food with the interest of the owner and cultivator of land.

It is by this means, and not by legislation alone, that England must hope to keep her present place among the nations. In this, as in all other things, she must vindicate her claim to "teach the nations how to live," and above all she must combine a tender regard for human life with the encouragement of those exertions by which alone life can be supported. By economy of time and labour, England has achieved her greatness; by continuing to practise the same economy in respect to all her immense resources, she must preserve it. Want treads upon the heels of waste, and waste of food, or of that which is the raw material of food, in spite of the wisest laws, will entail upon us a continuance of the great evil under which this country has so often suffered—a high price of the first necessaries of life. Health and Plenty, the twofold theme of this evening's lecture, should be the first object of a nation's care; for health is the parent of wealth, and abundance the only sure source of all civilization—the only safe guarantee of national prosperity.

APPENDIX.

Appendix A.

Mortality of Towns.

The following tables will serve to illustrate the mortality of large towns. They are formed from materials obtained from the Reports of the Registrar General.

Mortality of Town and Country contrasted.

	Country Districts.	Town Districts.
Population to a square mile	199	5,108
Annual deaths in 1,000,000 living	19,300	27,073
Rate of Mortality	1 in 52	1 in 37
Annual excess of deaths in town districts		7,773

Mortality of large Towns, (1840, 1841, 1842.)

	Deaths per 1000.
Liverpool	35
Manchester	32
Bristol	31
Hull and Leicester	30
Preston	29
Bolton, Nottingham, Salford, and Wolverhampton	28
Ashton and Oldham, Birmingham, Bury, Leeds, Newcastle, Sheffield, Wigan	27
Bath, Coventry, Derby, Dudley, Rochdale, Shrewsbury Sunderland, Walsall	26
Carlisle, Gateshead, Norwich	25
Bradford, Clifton, York	24
Tynemouth	23
Aston and Basford	22
Halifax and Kidderminster	21

	Population 1841.	Annual excess of deaths above 2 per cent.
Liverpool, &c. &c.	2,791,835	20,101
Metropolis	1,873,817	8,404
Total	4,665,652	28,505

Appendix B.

Analyses of Sewer-Water.

The following table shows the quantities of the several constituents of plants contained in the water discharged by the River Medlock on the 2nd of October, 1845, that day being regarded as a fair average. It is taken from a recent report on the improvement of Manchester. The analysis is by Dr. R. Smith.

	Per diem.	Per annum.
Potass	178 cwt.	3,200 tons.
Soda	257 "	4,640 "
Lime	940 "	16,900 "
Magnesia	9 "	160 "
Phosphoric acid	71 "	1,280 "
Silica (in solution)	266 "	4,800 "
Alumina (ditto)	18 "	320 "
Oxide of Iron	124 "	2,240 "
Sulphuric Acid	444 "	8,000 "
Chlorine	151 "	2,720 "
Organic Matter, 1,355 cwt., containing 6 per cent. of Nitrogen, or	80 "	1,440 "
Insoluble matter, chiefly silica, alumina, and iron.	1860 "	33,600 "

A specimen of sewer-water collected at four different times of the day from the King's Scholars' Pond Sewer, gave the following results:—

Matters in solution, per gallon	80 grains.
Matters in suspension, per gallon	1000 grains.

This specimen of sewer-water having been collected on a day on which no rain fell, is very rich both in soluble and insoluble matters.

An analysis of the sewer-water of Edinburgh as it flows from the sewer, gave 82·7 grains of solid matter in solution, and 244 grains of solid matter in suspension.

The 50 grains of saline matter assumed in the text, is therefore in all probability, very moderate.

The following table is important, inasmuch as it shows the value of the principal constituent of sewer-water. It will be found at length in the Report on the improvement of Manchester.

	Carried away from 50 acres of wheat and barley and 50 acres of green crops.	Excreta of 100 adults.
Potass and soda	780 lbs.	827 lbs.
Lime and magnesia	948	3158
Phosphoric acid	1549	1713
Silica	450	166
Metallic oxides	8	6
Sulphur and chlorine	21	87
Nitrogen	2681	2312

With the exception of silica, nitrogen, and metallic oxides, all the elements of the food of plants exist in the excreta of an adult in quantity more than sufficient to manure an acre of ground. The remaining silica and metallic oxides are contained in the unconsumed products of the soil, and the remaining nitrogen is partly in them, and partly exhaled from the human body.

APPENDIX C.

Illustrations of the Value of Sewer-Water.

"Edinburgh has many advantages over many of her sister cities; and the large supply of excellent spring-water is one of the greatest blessings to her inhabitants, both in respect to household purposes and in keeping the streets clean, and lastly in irrigating the extensive meadows situated below the town, by the rich stuff which it carries along in a state of semi-solution, where the art of man, with the common-sewer-water, has made sand-hillocks produce riches far superior to anything of the kind in the kingdom or in any country. The effect of the water is astonishing; they produce crops of grass not to be equalled, being cut from four to six times a-year, and given green to milch-cows. The grass is let every year by public auction, in small patches, from a quarter of an acre and upwards which generally brings from 24*l.* to 30*l.* per acre. This year (1826) part of the Earl of Moray's meadow gave as high as 57*l.* per acre."—*From Mr. George Stephen's Essay on Irrigated Meadows, published in* 1829, pp. 72, 73.

"The practical result of the application of sewer-water is, that land which let formerly at from 40*s.* to 6*l.* per Scotch acre, is now let annually at from 30*l.* to 40*l.*; and that poor sandy land on the sea-shore, which might be worth 2*s.* 6*d.* per acre, lets at an annual rent of from 15*l.* to 20*l.* That which is nearest the city brings the higher rent chiefly because it is near and more accessible to the points where the grass is consumed, but also partly from the better natural quality of the land. The average value of the land irrespective of the sewer-water application may be taken at 3*l.* per imperial acre and the average rent of the irrigated land at 30*l*, making a difference of 27*l.*; but 2*l.* may be deducted as the cost of management, leaving 25*l.* per acre of clear annual income due to the sewer-water." —*Evidence of James Smith, Esq. Deanston. Report of the Health of Towns' Commission.*—Part ii. Appendix, p. 326.

"Some of the meadows irrigated by the sewage-water of Milan, yield a net rent of 21*l.* per tornatura, (a measure of 10,000 square metres, equal to about two acres and a-half,) besides a land-tax of 61 francs 10 cents, the expenses of administration, repairs of buildings, &c. These meadows are mowed in November, January, March, and April, for stable-feeding; in June, July, and August they yield three crops of hay for the winter; and in September they furnish an abundant pasture for the cattle, till the beginning of the winter irrigation."—*First Report of the Health of Towns' Commission.*—Vol. ii. p. 403.

Several instances have been recorded of the excellent effects produced by irrigation with water, containing but a small quantity of sewage manure. One of the most striking is that of the Duke of Portland's water-meadows at Clipstone Park.

"The land immediately occupied by these meadows was, in its wild state, a line of hill-sides covered with gorse and heather—a rabbit warren, over which a few sheep wandered— and a swampy valley below, thick set with hassocks and rushes, the favourite haunt of wild ducks and snipes; through which the little stream, the Mann, wound its way in its descent from the town of Mansfield.

"The whole tract, both upland and lowland, was of very little value. The valley was in many parts from nine to ten feet deep in bog, and almost worthless; the hill-sides varied in quality, but 80*l*. a-year would have been a full rent for the 300 acres. Indeed, the whole of the Clipstone Park Farm, when taken in hand in the year 1816, containing 1,487 acres, had been let for the sum of 346*l*.

"The effect of this irrigation has been to raise the annual value of this land to 11*l*. 4*s*. per acre."—*Journal of the Royal Agricultural Society of England.* Vol. i. 1840, pp. 356, 367.*

APPENDIX D.

Cost of Conveying and distributing Liquid Manure.

"The cost of transmitting water to a distance of five miles, and to a height of 200 feet, including wear and tear of pumping machinery, fuel, labour, interest of capital invested in pipes, reservoirs, engines, &c., amounts to about 2½*d*. per ton. The cost of cartage to the same distance and height will, under favourable circumstances, amount to 4*s*. per ton."—*Evidence of T. Hawksley, Esq. First Report of the Health of Towns' Commission*, p. 322.

"It is quite clear that a very great weight of liquid material may be moved by pumping more cheaply than by any other known mode of conveyance."—Ibid. p. 322.

"On a full examination of the evidence adduced, and of the evidence indicated, it will, I trust, be found satisfactorily established, that the houses of towns may be constantly and rapidly cleansed of noxious refuse by adaptation of drains and public sewers, and that by such an adaptation, for one street or one district cleansed at the present expense, three may be cleansed by the proposed mode; that the natural streams flowing near towns may be preserved from the pollution caused by the influx of the contents of the public rivers, by the conveyance of all refuse through covered pipes; and that the existing cost of conveyance, by which its use for production is restricted, may be reduced to less than one-fortieth or fiftieth of the present expense of removal by hand labour and cartage."—*Report of the Poor Law Commissioners*, &c., p. 63.

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* The reader is referred for an analytical digest of the leading facts relating to this subject, to the prospectus issued by the Metropolitan Sewage Manure Company.

"By the application of capital and machinery, the cost of conveyance of substances in suspension in a fluid, even at the water companies' prices, may be rendered thirty and even more than forty times as cheap as collection by hand labour and removal by cartage. In the metropolis, where the persons who water the roads may obtain water gratuitously from pumps, the water supplied by standpipes by some of the water companies at 1*l.* per 100 tons is found to be twice as cheap as the mere labour of pumping the water into the cart."—Ibid. p. 53.

"The expense of distributing the same quantities of manure, irrespective of the different degrees of productiveness from the different modes of application, would be on the average, for distribution in the solid form, about 3*l.*, and in the liquid form, by irrigation, about 6*s.*"—*Mr. Dean. First Report on the Health of Towns' Commission.*

Appendix E.

Practicability of the proposed Plan of Conveying the Liquid Manure by Pipes, and Distributing it over the Land by Jets.

"The water could not well be distributed over the open tillage land by irrigation; it would therefore be necessary to resort to some mode of distributing it by jet. This requires the conveyance of the water in pipes, under a pressure of from 100 to 150 feet of altitude, to a number of convenient points in the different farms where it is to be used. In this there is no difficulty; it is a simple engineering question, the success of which is certain, while the cost can be estimated on known data. I made an experiment, on a large scale, at the Southwark Water Works, which satisfied me of the practicability of distribution by the jet. With an altitudinal pressure of 120 feet of water, and using a 2½ inch hose with a discharging orifice or nozzle of one inch in diameter, I found that I could, from one point, distribute water over an area of two statute acres—but, to be safe, say one statute acre. Dividing the quantity so required annually into three portions, for separate applications, one jet of one-inch orifice will deliver each portion in about an hour, as ascertained from data founded on an experiment made the same day to ascertain the quantity of water discharged in a given time from a similar orifice with a similar pressure."—*Evidence of James Smith, Esq., of Deanston, Report of Health of Towns' Commission.* Part ii., Appendix, p. 327.

Since the first edition of this Lecture was published, I have witnessed an important experiment which fully proves the practicability of this mode of distribution.

APPENDIX F.

Observations on the proposed modes of dealing with the Contents of the Sewers.

Two methods have been proposed for applying the valuable refuse of towns to agricultural purposes. They are the exact counterparts of each other. The one collects the *solid* the other the *liquid* manure; the one constructs gigantic and costly works along both banks of the river in order to intercept the contents of all the sewers; the other adopts the more economical plan of dealing with single sewers or groups of sewers in detail: the one uses extensive open tanks, or settling ponds, the other covered wells: the one conveys all the refuse of the town to a distant point, so that, even if convinced of the error of wasting the liquid manure, the benefits of its distribution would be confined to a part only of the environs of the metropolis; the other diffuses its benefits equally over the surrounding country: the one resorts to the *dearest* the other to the *cheapest* mode of conveyance: the one produces a solid manure, of which a large proportion consists of mere silt, and the remainder must be injured by the proposed admixture of lime; the other has made to its hand a liquid manure, abounding in all the elements of plants, and which it takes care not to deprive of any of its valuable constituents.

Such are some of the leading features of the two plans. It will be seen that the first plan is open to the following fatal objections. 1. It must entail an amount of expense, for which, in the present state of the money market, there is no hope of making provision. 2. The settling ponds, wherever they are situated, must create, on a gigantic scale, the worst nuisance of Edinburgh and Paris. 3. The solid manure, containing so large a proportion of silt, must have a very low value, which would be still further diminished by the proposed method of treating it with lime. 4. The expense of conveying the solid manure would still further depreciate its value as an article of commerce. 5. As its efficacy, like that of all solid manures, would be contingent on a fall of rain, or on artificial irrigation, its value would be liable to be still further depreciated by frequent experience of its failure. 6. If a supply of liquid manure should be grafted on the original plan, it could not be carried into effect to any extent without enormous expense, as the mains would have to be carried back to the remote districts from which a great part of the contents of the sewers had been derived. On the other hand, the second plan has these strong arguments in its favour:— 1. It can be carried out on a limited scale, and with a moderate capital, whereas the rival plan presupposes an enormous expense, before the process of collecting and manufacturing the solid manure can come into operation. 2. It creates no nuisance. 3. The liquid manure is acknowledged to be the most valuable in existence, and in the best form for application to the land. 4. The mode of conveying and distributing it by pipes and hose is obviously in the highest degree economical. 5. Its value is not contingent on rain or a supply of water from other sources, but it is most efficacious when solid manures are least so. 6. It will be much easier to graft a mode of collecting and using the solid contents of the sewer-water on the original plan of distributing the liquid manure, than it could possibly be to add the distribution of the liquid to the plan of using only the solid contents of the sewers. Lastly, (and this is an immense contingent advantage,) the same machinery by which the liquid manure is distributed, may be made subservient to irrigation in seasons of drought.

It may be well to correct one or two errors into which the opponents of the liquid-manure system have fallen, by stating that the sewer-water, instead of being, as is often supposed, a thick, muddy substance, which it would be impossible to transmit through pipes, is to the full as manageable as the water of the Thames, and that, instead of being a nuisance to the inhabitants of the country, its odour is both less offensive and more transient than that of the solid manures now in use. The gases which arise in a concentrated state into houses and through gulley-holes, will be dissolved in water, spread over a large surface, rapidly absorbed by the soil, and freely exposed to the air.

It is necessary to notice one other objection to the liquid-manure system, namely, that 'while the liquid is pumped away, the solid matters are left behind to clog the sewers or to pollute the Thames. To this objection there are two answers. The liquid may be pumped away with all the matters which it holds suspended; or, if this should be deemed objectionable on the ground that the machinery might be injured and the pipes clogged, the following plan might be adopted. The sewer-water may be made to flow through a grating with openings of a quarter or half-an-inch in diameter, by which fragments of stone, brick, wood, cork, &c., may be arrested. These should be sorted, and such as are combustible, burned in the furnace. The sewer-water should then be received on a fine inclined sieve, or series of sieves of different degrees of fineness, so as to arrest the smaller floating matters. These should be collected, mixed with the ashes of the furnace, and, if necessary, with half-burned peat, saw-dust, or burnt schale, and compressed so as to form dry inodorous cakes of solid manure. The liquid which passes through carries with it a certain proportion of silt, consisting of small fragments of granite, mixed with iron, some organic matter and salts. This from its great weight will fall to the bottom of the well in from one to two hours, and may be removed in any convenient manner. Though much less valuable than the floating matters, it is not valueless, for crushed granite is already in use as manure, and the silt consists of this substance mixed with a certain proportion of the more valuable matters just specified. The sieve might be in the form of a cylinder revolving on its axis, or an inclined plane resembling the machinery of a paper-mill. Such is the plan which I have been induced to suggest as strictly subservient to the distribution of the liquid manure, but, at the same time, as possessing several obvious advantages, and combining, in a perfectly inoffensive manner, the best parts of the two plans which I have just contrasted; its peculiarity being, that it deals with the solid matters not primarily as a manure, but as a nuisance, and that it economises *all* the constituents of the sewer-water.

APPENDIX G.

Economy of Sanatory Measures.

Mr. Banfield, after estimating the savings which might be effected by the abolition of the Corn Laws, the reduction of the duties on sugar, the removal of duties on articles of necessity and raw produce, and the disuse of intoxicating liquors, at £55,000,000, goes on to say, "this divided amongst five and a half millions of families gives £10 10s. per annum, or five shillings a week additional to each. I am inclined to estimate the money saving that may be achieved by improving the health of towns at a sum equal to this."—*Four Lectures on the Organization of Industry, being part of a Course delivered in the University of Cambridge in Easter Term,* 1844, p. 78.

APPENDIX H.

"The recent urine of one cow is valued in Flanders, where liquid manures are highly esteemed, at 40*s.* a year. It contains on an average, as we have seen, 900 lbs. of solid matter, and this estimated at the price of guano only, is worth at present £4 sterling. Multiply this by 8 millions, the number of cattle said to exist in the United Kingdom, and we have 32 millions of pounds sterling, as the value of the urine, supposing it to be worth no more than the foreign guano. It is impossible to estimate how much of this runs to waste, but one-tenth of it will amount to nearly as much as the whole income-tax recently laid upon the country." — *Johnston's Agricultural Chemistry and Geology,* p. 681.

APPENDIX I.

Estimates of the value of Town Manure.

In Flanders, where much manure is used, the collected excrements of a man are valued at 1*l.* 17*s.*"—*Dr. Lyon Playfair. Health of Towns Commission.* Part ii., Appendix, p. 47.

"I have ascertained that the quantity of sewer water due to a town of 50,000 inhabitants amounts to about 1,190,080,946 gallons per annum, which quantity will yield an annual application of 17,920 gallons per acre to an extent of 66,410 acres. Taking the average cost of guano and farm-yard manure at 2*l.* per acre, and deducting 12*s.* 9*d.*, the cost of the application of the Sewer Water, there will appear a saving due to the Sewer Water of 1*l.* 7*s.* 3*d.* per acre; allowing one half thereof to go to the farmer, there will remain a free income due to the Sewer Water of 45,241*l.*, which is nearly 1*l.* per head of the population."—*Evidence of James Smith, Esq., Deanston. Report of the Health of Towns Commission.* Part ii., Appendix, p. 328.

"Taking a general view of the subject, we may assume a clear revenue from the Sewer Water of all towns of 1*l.* for each inhabitant, either in a direct money return, or partly to the inhabitants in a reduced price, from the increased abundance of produce."—*Ibid.*

"The value of town manure may be estimated by the fact, that a portion of the drainage of Edinburgh, spread upon certain level lands towards the sea, has increased the value of these lands by more than 5000*l.* a-year; and that, if the whole drainage of London could be so used, at a sufficient distance from the town, the value would exceed 500,000*l.* a-year. Now engineers, who pump from the Thames many miles above London to supply pure water to the inhabitants, could as easily, by pumping away to any desired distance the fluid from the drains, supply the most valuable manure yet known (fluid town manure) to the horticulture and agriculture of the district; and the purity and beauty of the Thames, where it passes through London, would be preserved. Fluid manure, by sinking at once into the earth, is much less offensive to the neighbourhood, and affects less the purity of the atmosphere, than an equal quantity of solid manure spread, as it usually is, on the surface of the earth."—*From Dr. Arnott's Report on the Fevers which have prevailed in Edinburgh and Glasgow,* p. 12.

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G. J. PALMER, SAVOY STREET, STRAND.

Health of Towns' Association.

UNHEALTHINESS OF TOWNS,

ITS

CAUSES AND REMEDIES:

BEING A

LECTURE

DELIVERED ON THE 10TH OF DECEMBER, 1845,

IN THE

MECHANICS' INSTITUTE AT PLYMOUTH.

BY

VISCOUNT EBRINGTON, M.P.

PUBLISHED BY THE ASSOCIATION WITH HIS LORDSHIP'S KIND PERMISSION.

LONDON:
Published at the Depot of the Association,
356 STRAND.
1847.

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Dr. Arnott's Report on the Fevers which have prevailed in [illegible]burgh and Glasgow, p. 12.

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A LECTURE,

&c &c.

Before I enter upon the subject which I have undertaken to treat of this evening, I cannot help expressing in the first place how much I felt flattered by the invitation I received from the Committee to deliver a lecture here, and how honoured I feel by the attendance so many of you have given.

We are met together to consider a subject in which we all are deeply interested, because the health, the tranquillity, the morality, nay, the Christianity of the people of this country are nearly concerned in the sanitary condition of their towns: and yet one upon which persons of all classes, all parties, and all creeds may, both in consultation and action, harmoniously combine, and cordially co-operate, because it affords no scope for political or theological differences.

I only hope that, though I cannot treat it as it deserves (and I assure you I am painfully sensible of my insufficiency), yet that I may at any rate assist in attracting to it the attention of others better qualified by knowledge and eloquence to do it justice, but above all, of those whose position gives them the opportunity of improving the health of the towns with which they are connected.

It seems to have been almost the universal impression of mankind, even in very early times, that a country life is more healthy, both in body and mind, than a town life. Classical writers are full of allusions to its superiority. A complete school of poetry, indeed, was formed (the pastoral) to celebrate the simple pleasures and occupations of rural life, and to contrast its health and happiness with the dangers and vexations of crowded cities. Nor have modern writers, either poets or philosophers, been wanting to perpetuate with all the graces of imagery and eloquence, the same opinions and feelings among us.

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1848.

And yet, in spite of this, we find that cities have increased and are increasing. In vain were statutes passed in the reign of Queen Elizabeth, forbidding the erection of any new buildings, or the conversion of existing ones into more, or even underletting them to additional inmates, within three miles of London and Westminster; in vain did Cobbett denounce the Metropolis as the wen of the country, an unnatural and pernicious excrescence, impoverishing the rest of the body politic; London is continually growing, and not London alone, but nearly all the great towns of the country at the same time. Indeed, one of the most eloquent preachers of the present day, Dr. Vaughan, head of the Independent College at Manchester, has written a book, of which the title and the argument is, that the present is "The age of great cities." In it he shows, I think, satisfactorily, that this tendency is irresistible, and that it is not in itself to be deplored; that though, owing to the denser congregation of human beings, there are more noxious influences at work, yet that on the other hand the greater wealth, intelligence, and enterprise, and the more constant habit of combination in a town, as compared with a rural, population, afford greater means of meeting and overcoming them; and, though he allows that in their present, not, he argues, their natural or necessary state, the health neither of the souls nor the bodies of the inhabitants of cities is properly cared for, he still maintains with Dr. Johnson, the superiority of their condition to that of the inhabitants of the country. With this question, on the present occasion, we have nothing to do. It is enough for us that there are and must be large towns; if their existence or increase be inevitable, we may not doubt but that it may be overruled for good. Let us, therefore, leaving all vague generalities, and dismissing from our minds all preconceived impressions, take as the basis of an estimate of their state, not the glowing descriptions of poets, or the indignant declamations of moralists and philosphers, but dry statistical tables, parliamentary returns, and official documents, drawn from unimpeachable sources.

We will take the registrar-general's tables of the mortality and causes of death in different places in the United Kingdom. We will compare district with district, and town with town, and having ascertained what is their respective mortality, we will proceed to inquire among what classes it chiefly prevails, and to what dis-

Dr. Arnott's Report on the Fevers which have prevailed in Edinburgh and Glasgow, p. 12.

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eases it is principally to be traced. When we have determined these points, and have learnt from the best medical authorities to what causes these diseases are attributable, we will proceed to examine into the actual condition and habits of the population of our large towns, and see to what extent they are exposed to these previously ascertained causes of disease and death.

The investigation will be, must be from its nature, a painful, and in many respects, a disgusting one. If to bring the facts of the case fairly before you, I am compelled to speak plainly on some subjects, from the mention, or even the thoughts of which we instinctively recoil, you will, perhaps, be tempted to ask why I thus harrow your feelings, and offend your delicacy to no purpose; to say,—"Why drag these things into the light? Why not leave them, if they exist, in the obscurity which has hitherto shrouded them? It is a sad picture; but what is to be done? Is this mass of misery and degradation removable at all? And if it be, whence are to come the funds for such a stupendous undertaking? What town can afford such sacrifices as this desperate enterprise of benevolence would require?"

I can only say that, if these evils were indeed necessarily inherent in the nature and constitution of towns, if their removal or mitigation was impracticable, I would not bring them under your notice. Nothing hardens the heart so much as the contemplation of suffering without making an effort to relieve it.

When I consider the complicated bearings of the sanitary state of our towns, such as I shall have presented to you upon the moral, social, political, and economical condition of our country, the difficulty is to know how to deal with them in one short lecture; but perhaps it will be best to consider it less fully in its effect upon men viewed as our brethren, responsible agents with immortal souls, and as citizens of the state and members of families, than as producers and consumers of wealth; not that the former are not infinitely more important, but because to such an assembly as the present it would be superfluous to enlarge upon the obligation of reforming a state of things which directly promotes a violation of the laws of God and the laws of our country. And when I come to the financial branch of the subject I think I shall be able to shew that much of this ill health and mortality is not only preventibile, but profitably preventible; that its cost to the community is far greater than that of prac-

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1848.

ticable measures for its removal and prevention; that for these no outlay is necessary such as ought not to be expected, not only from a Christian community as a reasonable sacrifice, but as a politic expenditure by a wise one, and a lucrative investment by a trading one; and this, while it will be the most powerful argument in favour of these measures with those (I trust there are none such present) who are most influenced by these considerations, will to those who act from higher motives, afford, as we examine into it, a direct proof of the habitual short-sightedness which Dr. Arnold denominated self-seeking, and the incompetence of self-interest alone, once so much vaunted as a guide, to work effectually on a large scale for the promotion even of its own ends.

But to commence with our statistics; the general average of mortality in England is 2·207 per cent. on the population, or 1 in 45; in fairly healthy districts only 2 per cent., or 1 in 50. I will compare this with that of Liverpool, 1 in 28·75, about 3½ per cent.; Bilston 3·4 per cent., Chester nearly 3, Gloucester 2·8, Birmingham 2·7.

That of the south-western district, which includes Cornwall, Devon, Somerset, Dorset, and Wilts, is only 1 in 52, not 2 per cent., while that of the north-western, including Cheshire and Lancashire, is 1 in 37. Now let it not be said that this is owing to extreme poverty and want of the necessaries of life; the condition of the labourers of the West, the badness of their dwellings, the lowness of their wages, the consequent scantiness of their food and clothing, have been the subject of public animadversion. With the exception of the Cornish miners, the condition of the labourers throughout the western counties is described as nearly the same; yet in Wiltshire, the county of lowest wages, the deaths are 1 in 49, in Lancashire 1 in 36. The average age at death in 1841, was in Wiltshire 35 years, in Lancashire 22, at Liverpool 17; that of the labourers in Wiltshire 33, of operatives in Liverpool 15. At Manchester in 1836 the average consumption per head of the population was 105 lbs. of butchers' meat—about 2 lbs. a week, exclusive of bacon, pork, fish, and poultry (what a different average would our county produce!); the average age at death was 20. The proportion of paupers in the 15 principal agricultural counties is 1 in 18, in the 12 principal manufacturing counties 1 in 13, in Lancashire 1 in 11; and of the deaths in 3½ millions of town, and about an equal number of a country population, were respectively in 1838 and 1839 together—

. Arnott's Report on the Fevers which have prevailed in
rgh and Glasgow, p. 12.

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Country	1 in 54·91, of whom above 70	20 per cent
Town	1 „ 38·16	9 „
All England	1 „ 46·00	14 „

I will not weary you with any more figures, but go on to the next point.

We have compared district with district and county with county; let us now compare the mortality in the best drained, best built, richest quarters of some towns, with that in the poor and neglected quarters.

That of the parishes in Exeter classed as well-to-do is	1·28 per cent.	or about 1 in 78
As poor	2·69, „	or about 1 in 36
Of the whole city	2·19, „	about 1 in 45

The average age at which the *gentry* die in St. George's Parish, Hanover Square, is	45
At which the labourers	27
Age at which *gentry* in Liverpool die	35
At which *operatives*	15
Age at which gentry die in Preston	47·39
At which operatives	18·28
Of children under five among the gentry, less than	$\frac{1}{4}$
„ among the operatives, more than	$\frac{1}{2}$

Mortality in Brecon.

In *St. Mary's Parish*, well drained, the residence of the rich	2·32 per cent.
In St. David's Parish, ill drained, the residence of the poor	3·3 „

Where the age of childhood has been passed, the greater proportion of these deaths are caused by consumption and typhus and scarlet fevers and measles—among infants by convulsions. In round numbers, of the 350,000 deaths in England and Wales in 1842, nearly 80,000 took place under 1 year old, and nearly 140,000 under 5 years.

25,488	died of convulsions.
16,201	of typhus.
12,807	of scarlet fever.
59,291	of consumption.
8,742	of measles,

I must add, though not of disease, 11,092 of violent deaths or accidents.

Dr. Guy, the physician to King's College Hospital, shews from the registrar-general's returns that out of 1,000,000 inhabitants of towns, more than 27,000 die yearly, more than 19,000 of the same number in the country. Out of this number 3400 in the country die of epidemics, 6000 in town, being a difference of 2600. But further, from convu sions, water in the head, and teething among infants, 13 die in the country, 3500 in the towns, difference 2200—a of consumption among adults, and scrofulous diseases, amo children, out of the same number there are 3800 victims the country, 4600 in the town, difference 800 from scroful add 2600 from epidemic and contagious diseases and 22 excess of infantile mortality; we get from these causes alo 5500 out of a million wasted in large towns as compar with the country.

Now with respect to the classes afflicted by these di eases—in St. George's, Hanover Square, only 2 per ce of the children of the gentry died under 10, but 26 per ce children of artisans. Not quite 1 per cent. of the deaths the gentry are caused by epidemics, but nearly 10 per ce of those of the working classes. Of the total deaths in Br con, 1 in 4½ was from consumption, 1 in 5·1 from epidemic from consumption 1 in 12 of the gentry died, 1 in 4 of t labourers; from epidemics, of which two-thirds we under 5 years of age, 1 in 7·2 among the gentry, 1 in 5 among the labourers. Similar results are found in oth places, so I will mention no more. I will only rema that the difference between the lives of tradesmen a operatives is generally far less than that between trade men and gentry. Dr. Guy, adverting to this, says rejoices at it, because he feels sure that the class tradesmen and operatives will contend together for tho just rights common to both—the right to good health, far as it is in the power of good laws well administered confer it.

Now let us hear what the best medical authorities sa about the causes of this great infantile mortality, of the fearful epidemics, of this wasting consumption, which crea so much greater ravages in our towns, as compared wi the country—in the working, as compared with the high classes.

To begin with infantile mortality, Dr. Duncan quot the Registrar of the Dublin Lying-in Hospital to she that in 1781, before ventilation was adopted there, eve sixth child died within nine days, of convulsions; aft thorough ventilation was adopted, only 1 in 20. M Toynbee attributes the prevalence of death from teethi and water in the head to the same cause as convulsion namely scrofula. Sir James Clark says that if an infa born of healthy parents and in perfect health be kept close rooms where cleanliness and ventilation are neglecte a few months will suffice to induce tuberculous cachexi or the seeds of consumption. Professor Alison attributes a large part of the infantile mortality to the want of fresh air and exercise, which is one powerful cause of scrofula.

With respect to consumption, my friend Mr. Toynbee told me that there was no doubt that consumption was of scrofulous character, and, like other scrofula, is caused by breathing air vitiated by repeated respiration; in his evidence he quotes M. Baudelocque, who, unknown to him, had arrived independently at the same conclusion—to the effect that if there is entirely pure air there may be bad food and want of personal cleanliness, but there cannot be scrofula; that the notion of its being chiefly an hereditary disease has arisen from the fact that the same family usually live together in the same manner, and are therefore affected by the same causes. That scrofula sometimes spares the children of scrofulous parents, badly fed, badly clothed, dirty, and living in damp and dirty dwellings; and attacks those of healthy parents, clean, well fed, and well clothed, but who upon examination always turn out to have passed some time in vitiated air. An eminent surgeon quotes several remarkable cases, among them one of a boy who had become scrofulous from a habit of sleeping with his head under the clothes; he gave up this bad habit and became perfectly healthy. Mr. Toynbee told me that he had just restored to perfect health a poor boy who was eaten up with scrofula, and on the point of becoming a cripple: he gave him no medicine, but with the help of a contribution from the clergyman, sent him instead to the top of Hampstead Heath for pure air, and that cured him I think in two months.

Now with regard to fever, the other leading cause of mortality. "That the congregation of persons," says Dr. Duncan, "in these small and pent-up areas where the atmosphere is vitiated not by respiration only" (which we have seen to be the chief cause of scrofula) "but of the poisonous emanations which arise from these bodies, is an efficient cause of fever, is a fact established by the concurrent testimony of nearly every writer of eminence. The operation of this cause in its highest intensity is shewn in the case of the Black Hole at Calcutta, where, out of 146 human beings who were confined in a space of about 5000 cubic feet (about 18 feet square) not more than 23 survived the night, and these were afterwards said to have been attacked by a fever analogous to typhus." It is still disputed among medical men whether the malaria

J. LUXFORD, 1, WHITEFRIARS STREET, FLEET STREET.

1848.

arising from decomposing animal and vegetable matter, such as the contents of ash-pits and cesspools, is sufficient in itself to generate fever; "but there is no difference of opinion as to the fact of the exhalations favouring in the highest degree the extension of the disease which has once appeared."

Before I leave this part of the subject, I will just mention that light, which plays an important part with regard to animal and vegetable life (for plants, we know, die or lose their colour in the dark, and tadpoles remain tadpoles all their lives, without changing into frogs) has also an effect, though not as marked a one, on mankind. Dr. Wylie says that there is a difference of three to one between the sickness among the soldiers on the light and dark sides of the barracks at St. Petersburgh; and Mr. Toynbee, Dupuytren, Dr. Edwardes, Mr. Ward, and Dr. Arnott distinctly assert that living in darkness acts very disadvantageously on health, especially in the case of children.

I could multiply medical evidence and statistical proof about causes predisposing to disease and favouring its extension, if not generating it, to an indefinite extent. The Reports of the Health of Towns' Commissioners, the Works of the able and benevolent Mr. Chadwick, those of Mr. Combe, Mr. Quetelet, Professor Alison, and the Journal of the Statistical Society, abound with them. But I have already dwelt too long upon this; and now, therefore, having ascertained by what diseases this awful mortality is caused, and under what circumstances they are generated and diffused, let us inquire what is the actual condition of those multitudes who inhabit our towns—of our fellow-creatures, our fellow-subjects, our Christian brethren I would fain have said, but alas! to our shame be it spoken, of our heathen brethren in this Christian country, would too often be their more appropriate designation.

The figures which I have given you, what a melancholy picture do they present when we translate these mere numerical results into the language of every-day life; when we think of the many scenes of suffering and grief, unnecessary suffering and needless grief, which almost every unit of the thousands of premature and preventible death in these latter represent, and the many terrible illnesses which did not terminate mortally! If we had nothing but these figures, how to those who interpret their mute voice aright do they speak in language of passionate appeal! but there is no lack of more detailed descriptions; the difficulty is one of selection only; whether we go to Scotland, Ireland, England, or Wales, whether we go north, south, east, or west, the same deplorable state of things prevails, with regard to the labouring classes. Filthy, crowded, dark, unventilated, undrained dwellings, some above and some under ground, —almost without water and almost without light, and workshops for their work, and schools for their education, and churches and chapels for their religious instruction, scarcely less unwholesome.

I will begin by a quotation from the very able report of my friend Mr. Clay upon the state of Preston, because in his company I visited the other day the localities which he describes, and saw them with my own eyes. I must premise that Preston is a very flourishing town of about 60,000 inhabitants, most of them employed at high wages. Messrs. Horrocks and Miller, for instance, employ 2,000 persons, and their average wages, man, woman, and child, are 10s. a-week each. It is considered generally orderly and quiet; yet such places as the following are to be seen there, and even they are cleaner now than they were before Mr. Clay's report was published.

"Back Queen Street is approached by several lobbies leading from Queen Street. A visitor, on entering the former, finds himself facing a row of privies, more than 100 yards long. The doors are about six feet from the house doors opposite, and the space between one privy and another is filled up with all imaginable and unimaginable filth; so that the street consists of a passage with dwelling houses on one side, and a continuous row of necessaries, dungheaps, pig-sties, ash-heaps, &c., on the other. The doors opening upon it are in some cases the back doors of Queen Street houses; but twelve houses have their only outlets, doors and windows, upon the disgusting and pestiferous passage. The deaths in 1841 were about 1 in 15 in these Queen Streets."

I can add nothing to this description—it is perfectly accurate—but Mr. Clay took me through a passage under a house to another court still more miserable, containing about a dozen houses, among which were lodging houses of the worst kind, which occupied three sides of a square. The fourth was blocked up by a wall with two doorless privies in front of it, in the full view of every person in the court; and these were all that those densely peopled houses had. This, however, is nothing to a district in Manchester, where 7000 people have only 33 privies amongst them, and another where there are none at all to three or four streets.

I have described to you what I saw at Preston, one of the most moral and healthy towns in Lancashire. I will now give you an account of a visit I paid, in company with my benevolent friend Mr. Toynbee, to a number of dwellings in the neighbourhood of Golden Square, close behind the magnificent thoroughfare of Regent Street. It is a quarter inhabited by the most respectable of the labouring classes. Suffering, but yet not degraded, they all received us with courtesy, and took kindly our few words of sympathy. Several, when asked what they earned and what they paid for rent, owned to poverty, but none either begged or hinted for money. They evidently did not expect any, and I offered none. They were all deeply sensible of the misery and sickness brought upon them by the condition of their dwellings, the impossibility of keeping them clean and tidy, and by the fetid smells to which even habit had not reconciled them; but they never murmured, or spoke unkindly of any one. These families, for the most part, have but one room, about twelve feet square, in which they sleep and live, and some carry on their trade besides. I found many of their rooms full of steam from clothes hung up to dry across the room, after having been washed, many of them successively in the same water, owing to its scarcity. In one, besides, there lay a child dead five days. We did not see one healthy face, either of adult or child. Many children were ill, some with measles, some with fever; many with scrofula, which had covered them with wounds. In every family we heard of sickness and death; some had lost two-thirds, hardly any less than one-half, their children. These houses had, for the most part, been once inhabited by separate families of some fortune, and were now partitioned off into lodging-rooms, at rent varying from 1*s.* 6*d.* a-week for a very bad cellar, to 5*s.* for a large upper room, the average being about 2*s.* 6*d.* In no case had they any but an intermittent supply of water at the bottom of the house, which, in some cases, was kept in water-butts of decaying wood. We never found more than one privy to each house, containing thirty or forty inmates; this was sometimes in the centre of the house, sometimes in a little hole of a back yard.

Some of these rooms were over crowded cow-houses, where cows, diseased by the badness of the air, supply

Dr. Arnott's Report on the Fevers which have prevailed in [illegible]burgh and Glasgow, p. 12.

LONDON:
G. J. PALMER, SAVOY STREET, STRAND.

the neighbourhood with diseased milk; some close to slaughter-houses, where I saw the steam reeking up from the hot carcases; some over cesspools, cleaned out at intervals of from five to seventeen years; the walls were filthy, the smells either abominable, or exchanged for a closeness still more oppressive; the passages dark and tortuous. And yet here were living the most respectable of the labouring classes—porters, policemen, and such like, who, though earning high wages, are pauperized by the expense of the sickness brought on them by these dwellings—dwellings for which they pay in rent for their one miserable room as much as Mr. Ashworth of Egerton, a manufacturer such as this country may well be proud of, receives from his prosperous workpeople for cottages, which I saw, containing five and six and seven rooms each, with every convenience.

This picture is sad enough, but it is nothing to what exists in other towns and other parts of the same metropolis. This is bad enough; but what must those districts be where to disease and misery, vice and ignorance and profligacy are added? I cannot read aloud the evidence about the lodging-houses in which human beings, our brethren of both sexes, are promiscuously packed, almost as close as the decks of a slave-ship, in the very room where patients may be dying of some contagious disease, nay, in the very sheets from which some victim of typhus fever has just been carried forth to his grave—such evidence as the Children Employment Commissioners give about the condition of the lower classes at Sheffield, for instance, or Leeds, of their precocious vice or premature decay; or what I have heard from eye-witnesses of that of the chapter property at Westminster. But what must be the religious and moral consequences of such a state of things! Can we wonder at the result? I only marvel it is not worse than it is.

All evidence, and a knowledge of our common nature, tell us that a continual recurrence of these scenes of sickness and death, instead of softening, usually hardens the heart. Read the accounts of all great plagues — the plague at Athens—the plague at Milan, as described either in the historians of the day and the biographers of Cardinal Borromeo, or in the more popular pages of the best Italian novel, the Promessi Sposi—read the account of the plague in London—and you will see that in all these cases the bulk of the people become more reckless and profligate than ever. But independently of this, the dreadful depression consequent on ill-health (and my companion, Mr. Toynbee, assured me that almost every one I saw was ailing) tempts these poor creatures, with a force which we cannot adequately appreciate, to have recourse to the stimulus of drink. Glasgow is full of spirit-shops, and in Glasgow there were more than 62,000 cases of fever in the course of five years! The temperance movement cannot be carried on successfully in such dwellings as I visited.

Next, the absence of all proper conveniences from the dwellings, and the crowded state of the rooms, which defies all attempts at decency and modesty, breaks down the barriers of self-respect, and prepares the way for direct profligacy. How can numbers, often not of the same family, sleep in the same room, nay, often in the same bed, without great danger? Dr. Southwood Smith on this subject, says: "I have sometimes checked myself in the wish that men of high station and authority would visit these abodes of their less fortunate fellow-creatures, and witness with their own eyes the scenes presented there: for I have thought the same end might be answered in a way less disagreeable to them. They have only to go to the Zoological Gardens, and to observe the state of society in that large room appropriated to a particular class of animals (the monkeys), where every want is relieved and every passion and appetite gratified in full view of the whole community. In the filthy and crowded streets in our large towns and cities you see human faces retrograding, sinking down to the level of these brute tribes, and you find manners appropriate to the degradation." *How little can schools or sermons do for people who live thus!* Shall we, who cheerfully paid twenty millions to rescue the negroes from earthly taskmasters, make no exertion to rescue tens of thousands of our countrymen from a slavery more degrading, whose consequences last beyond the grave? I said, is this to be tolerated in a Christian country? — I would ask, is it to be acquiesced in by a prudent one? Do we not know that vice leads to crime — that disregard of God's law leads to the violation of human laws? Take the return of any gaol, and see how many more offences originate in drunkenness and profligacy than in distress. I will take that of Preston, because Mr. Clay, the chaplain there, being trusted and loved by his fallen but not irreclaimable flock, has the best means of learning their previous history. Out of about 1000 men and 200 women, only 80 men and 16 women

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Dr. Arnott's Report on the Fevers which have prevailed in [illegible]*burgh and Glasgow*, p. 12.

LONDON:
G. J. PALMER, SAVOY STREET, STRAND.

were led to the commission of the offence they were imprisoned for by distress. Out of 301 sessions cases there, drunkenness was the cause of 124, and profligacy of 93; distress of 12.

I told you that the quarter of London I visited contained the best of the working classes. Few, if any, are born there. It is a shifting population. Mr. Toynbee told me that almost all the children who survive the dangers of that pestiferous air, leave that quiet and orderly quarter, as they grow up, and migrate to some of those more dreadful places where wickedness finds a congenial home in the midst of filth, disease, and death. Read the Reports of the Constabulary Commissioners, and learn from the adventures and narratives there recounted by prisoners, what deep-seated and wide-spreading evil pervades our social state.

Why should creatures living so wretchedly fear a change for the worse? They have nothing to lose in this world; and such is their ignorance that the next has no terrors for them. Take again the gaol returns of Preston: of the prisoners tried for felony, seventy-three, ignorant of the Saviour's name, were familiar with the histories of Dick Turpin and Jack Sheppard. A larger per-centage of the others knew these histories better than the names of the months of the year, or the meaning of the words "vice" and "virtue." Mr. Clay mentions a map of the town coloured darker according to the intensity of filth and squalor, with the houses marked on it where criminals had resided, and where epidemics had caused death; and sums up the result by saying that "dirt, disease, and crime are concurrent." Read Parent Duchâtelet's Account of the Dwellings and Habits of the "Classes Dangereuses" at Paris, and you will only wonder that the French Revolution was not more sanguinary and terrible.

One other circumstance just deserves notice, namely, that fever chiefly carries off men between twenty and forty —heads of families. In the population of an unhealthy town there is therefore always a much larger proportion of young men than in a healthy one. This comparative absence of the influence of older and therefore more moderate men from the masses in these towns is, as far as it goes, an additional element of disturbance there. But in truth there are too many other demoralizing influences at work, such as the lack of all instruction, or, where instruction is given, the lack of moral and religious training, without which instruction is comparatively valueless— the high price of youthful, as compared with adult labour,

and the consequent independence among young pe
of parental controul—to allow us to attribute the
state of Sheffield and other towns to the conditi
their dwellings; but I think I have succeeded in sh
that they have had their share in producing the mat
for the following Report of the Commissioner, Mr
monds:—"Habits of drinking begin at an early age
the evidence might have been doubled which attest
early commencement of profligate intercourse among
and girls." After some further details, he says, "
being the case, it is by no means surprising that c
and outrages of no ordinary description should occu
Sheffield. Within a year of the time of my visit (1
a large body of men and boys marched on it in the
of night, and a very large quantity of crows'-feet to
horses, pikes, and combustibles, were found on t
in their houses, and left on the road. Several were ple
to fire their own houses. I name this as a further i
tration," he adds, "of the perilous ignorance and
prevailing among that young class between boys and
grown men, who were known to be the chief actors in t
scenes."

We have now had a faint description of the state of p
of our large towns, and have just glanced at the social
political, as well as the moral and religious, conseque
resulting from this state of things: let us next inquire w
is the cost of it. This must be considered under sev
heads.

It may be premised as a general principle, that a cr
nal, and next in degree a sickly, population must be
pensive to a community. The wealth of a country con
in the wealth either in the property or labour of its
habitants individually and collectively. The sick and
criminal have to be supported themselves, with their fa
lies, out of the property of the country. The crim
inflicts a heavy expense upon society besides, in p
cautionary measures, such as police; in loss and wa
such as robbery and arson; in prosecution and in s
sequent punishment (except in the case of public exe
tions or whipping, which, though not directly expens
exhibits to the people a brutal and brutalizing specta
and excites sympathy rather than terror in the beholde
It was calculated the expense and loss to the town
Liverpool (with a population of 220,000) arising fr
the vice and crime of 4700 vicious characters resid
there, was £700,000 a year: a statistical society th

thinking this calculation was exorbitant, went carefully over it, and pronounced that it was rather under than over the mark. The number of depredators, offenders, and suspected persons in Liverpool is 1 in 45; in Bath 1 in 37; in Bristol 1 in 31; in Newcastle-on-Tyne 1 in 27. In all these the mortality among the poorer classes is very great. We have seen, to use Mr. Clay's words, that dirt, disease, and crime are concurrent; so we may reasonably assume that sanitary measures, though insufficient of themselves to cope with the depravity of the human heart, will, as far as they go, tend to improve it.

We have taken now the most obvious expense arising out of sickness: let us examine a little further.

While the man is sick, not only is he consuming, but he is also not earning. The fever-bill should include the minus as well as the plus. If a man who was earning 10s. a week falls ill, and with his family costs the parish or his club, or takes out of the savings' bank, 10*s.* a week, the loss from preventible disease to society will be increased by the 10*s.* worth of work which he has not done. In the calculations of the cost of illness in several towns, which I will presently submit to you, the loss of a man's labour weekly is estimated at 10*s.*, of a woman's at 5*s.*; giving an average of 7*s.* 6*d.* for each adult individual.

But all who fall ill do not die. It has been calculated from the books of a great number of sick-clubs, hospitals, &c. &c., that only one in twenty-eight of those who are ill die, and that each illness, long and short, may be averaged at a fortnight; then, in a population where the mortality is 3 per cent. per annum, there would be three constantly sick; each individual would, on an average, have eleven or twelve days' sickness. Dr. Playfair takes it at three weeks. Dr. Southwood Smith finds that in the Fever Hospital one-seventh die; that the average length of absence from work of each patient is six weeks; and that each case, where the patient recovers, costs about £1.

But this is not all. Let us for a moment put out of view the spiritual part of man, which must live for ever in happiness or misery, and let us consider him as a producer of certain things wanted by society. Let us consider the country as a large farm, and the inhabitants as stock.

For many years of a man's life he is quite incapable of supporting himself. At an age when, by means of their instincts, all other creatures are able to provide for themselves, he is still helpless, and for many years after in these densely peopled countries, though not wholly unproductive, he is not worth his meat. It is obvious that the wealth of society can only be increased by the average of mankind's living, till by their labour they have produced,—1st, more than they consumed while children; 2nd, more than will be necessary to provide for them when they become again incapable of work. Professor Macculloch considers that by the time a man comes to his full strength, he has 300*l.* of capital invested in him. On the average, men in good health go on working till 60 or 65 years of age; if he dies before, there is a loss to the community of the labour that might have been expected of him.

The proportion of early deaths, even in healthy places, is so great that we cannot expect so high an average duration of life; but there seems to be no reason why the average length of life should not reach that of the Ulverstone district in Lancashire, or the Tiverton district in Devonshire, where I know of my own knowledge that there are many unhealthy circumstances admitting of improvement. The Tiverton average is 41 years 6 months for all born, and 62 years 4 months for each above 20 years. Taking this standard, every individual in Liverpool loses on an average 21 years of his life, and every adult 12½. Now, in Plymouth, every individual on the average loses 9 years 3 months, and every adult 4 years 8 months; which gives a loss in labour to each adult, on an average of 91*l.*, taking the money value of productive labour in men at 10*s.*, in women at 5*s.*, or each individual at 7*s.* 6*d.* a-week; but these averages, after all, do not represent the whole force of the case; fever kills about one-eighteenth of all who die, and we know that it kills more between 25 and 40 than at all the other ages. It is almost entirely a preventible disease.

What should we say of the farmer who reared his colts only to let them die of preventible disease just after they came into work? and is not our folly, to say nothing of our cruelty, as great in rearing labourers only to let them be cut off just as their labour has begun to be profitable to the community? Of course, the most valuable labouring population to a country is that which contains the largest proportion of effective, and the smallest of non-effective persons.

We have already considered the expenses of sickness under three heads:—1st, its direct cost in the maintenance and attendance on the sick and their families; 2nd, the loss it entails of what the sick were producing while they were well, and would have continued to produce if they had

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Dr. Arnott's Report on the Fevers which have prevailed in Edinburgh and Glasgow, p. 12.

LONDON:
G. J. PALMER, SAVOY STREET, STRAND.

tinued well; 3rd, the loss it entails upon the community,
cutting off prematurely numbers who die before they have
paid to the community what their maintenance cost before
ey were able to maintain themselves. Let us examine a
tle further into its workings.

In general there is a certain quantity of employment in
ch place, which employs a certain number of labourers.
hen these get regular work at regular wages, they usually
arry. If, instead of filling up the same place till between
and 60, which in the course of nature he might perfectly
, the head of the family is prematurely cut off at 25 by
eventible disease, what happens? His widow and
ildren are left dependent on the parish, and his place is
led up by another, who, on the strength of it, does as he
d done—marries and has a family. In this manner, three
ccessive labourers, all having families on the parish, some-
nes occupy in turn a place which one man might have
led during the whole time. This happens frequently in
wholesome employments or situations; that is, employ-
ents or situations which our ignorance, our carelessness,
our selfishness allow to be unwholesome. No employ-
ent necessary for our support, and few, if any, indis-
ensable for our comfort, or even luxury, are inevitably
. The manufacture of glazed cards is, I believe, still one;
e need not, and ought not to use them. Many, as at
esent conducted, are unwholesome, but need not con-
nue so.

The dry-grinding at Sheffield was, in all factories—and
ontinues, I am ashamed to say, in some—so pernicious to
ealth, that a medical man told me he had actually observed
e most drunken men were the longest lived among them,
mply because they spent in the destructive swallowing
spirituous drinks, many hours which the others passed
the still more destructive swallowing of dust from the
rindstones. A complete preventive of this evil was dis-
overed, but some masters refused to put it up, and many
orkmen refused to use it, from the fear that the wages
their work would be reduced if it were rendered less
eadly. "A short life and a merry one." Can a more
elancholy corroboration be afforded of the previous
vidence I had given you respecting the degraded state of
heffield?

In this manner the families of several short-lived
bourers successively may be said to be called into exist-
nce by employment which only suffices for the main-
enance of one, and which, if the health of the labourers

had been attended to, would only have called one into existence during the natural duration of a man's working career. Thus you see, that besides the reckless and improvident unions formed by the degraded victims of our selfishness and neglect, whom we have left in a brutal state, and from whom, therefore, we have no right to expect the foresight, the prudence, the love of decency and of independence which ought to characterize a free man; besides these, there are a number of marriages annually contracted, not imprudently or improperly, by perfectly respectable and prudent persons in the receipt of wages quite justifying their taking such a step, whose prudence and industry, nevertheless, is neutralized through our neglect, and rendered inoperative to protect their families from the degradation, and the community from the expense, of parochial relief.

Professor Owen gives us 18 per cent. out of the total cost of the paupers of the Lancaster union, as the cost of maintaining the widows and orphans of husbands and fathers, all dying under 60, whose average age at death was 38½ years. Mr. Chadwick calculates that about 27,000 cases of widowhood and 100,000 of orphanage arise from preventible and removeable causes, every year, in England.

Now let it not be supposed, as it is by some, that fever and pestilence, except in the extremest cases, tend to diminish population; quite the contrary. In Glasgow, where the mortality is frightful, and the average duration of life is very short, when, in the year 1837, the deaths from fever were more than 2000 (nearly 1 per cent. on the population), the births were more numerous than the deaths. Still more responsible and immortal beings yearly brought into the world (with what prospects!) than are untimely removed to another,—Alas! must we not shudder when we ask again, With what prospects?

In very extreme cases, certainly, famine and pestilence do diminish population; they did so largely during the decline and fall of the Roman Empire, when nature resumed her sway over vast districts long subdued by man's industry, and the stillness of the forest succeeded to the busy noise of cities. They have done so, as the prophets foretold, in the plains of Babylon and hills of Palestine. But this extreme check to population can hardly be said to apply to a rich and flourishing country like ours, much less to a Christian country, where the law most properly says, that no one shall starve while his neighbour has enough and to spare. The two causes already mentioned,

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Dr. Arnott's Report on the Fevers which have prevailed in Edinburgh and Glasgow, p. 12.

LONDON:
G. J. PALMER, SAVOY STREET, STRAND.

amely, the recklessness of the degraded class, and the apid succession of occupants of each workman's place, uite account for it—with one other circumstance which I ill not scruple to mention, for on subjects like these it necessary to speak plainly. Mr. Toynbee assures me nat the prevalence of infant mortality, by releasing the nother's system from the drain which the nourishment of ne child entailed upon it, tends to the increase of popuition. Thus are the little victims multiplied only to be ffered a sacrifice to the Moloch of our selfish carelessess.

But I have not yet done with the pecuniary losses ttendant upon ill health and mortality; there comes the xpense of funerals. This is no small item. The funeral exenses of this country amount to about 6,000,000*l.* a year,—o slight sum—much of it employed as in this town at present, hough I am glad to find it is not to be for much longer, in lacing the dead where they will do the greatest possible njury to the living, where they will as soon as possible ring others to lie by their side, who will in their turn dd to the destructive agency already at work, and bring yet larger supply to swell the grave-yards even to overlowing, to pollute the air, to poison the springs, to harrow he sensibilities of the survivors, or after a time render hem callous by accustoming them to painful and revoltng spectacles. Now not only are the deaths too many, out they occur too soon. Think what the compound nterest of the funeral expenses must be, for a number of ersons who die at 25 instead of living to 65! and quite ncidentally I will take the liberty of saying, think what he compound interest for forty years must be for such xtravagant charges as the present charges for interment n this country, compared with the small sum for which he last sad rites are far more appropriately and decently done under municipal legislation at Paris, at Frankfort, and elsewhere on the continent! In the calculation of expense caused to the country by preventible disease, each funeral is put down at 5*l.*, a very moderate sum indeed. This loss at Liverpool amounts to more than 18,000*l.* a year; in Plymouth to 230*l.*, taking the duration of life at Tiverton as our standard.

I will now read you some calculations of the losses from ll health and death to several towns, including Plymouth, all framed on the basis I have endeavoured to explain to you. [These are omitted, as not likely to prove interesting to the general reader. The Preston Tables, at page 32, may be taken as a fair specimen of the general results afforded by the tables for other towns.]

I have now traced the ill health of towns through some of its consequences upon public morality, upon public tranquillity, upon public wealth: I have attempted very feebly and shortly—from the mouths of one or two witnesses only, for I could not bear to dwell long on such painful details—to lay before you the condition in which vast numbers of our poorer brethren live and die. Harrowing and appalling as is the picture—and I can truly say that after reading some papers of Mr. Alison's on pauperism in Scotland, and some of the official documents to which I have referred, I was haunted at night by the dreadful images which my reading in the day suggested—all this accumulated mass of spiritual, social, and physical evil never for a moment led me to despair.

I entered upon the study of these questions some years since, with the most perfect conviction that in these, as in all the other workings of the Almighty, further investigation would shew that the course of action dictated by Christian charity would prove to be that required by enlightened policy; with the fullest confidence that, inscrutable and mysterious as these dark dispensations at first appeared, laws and principles must be discovered in these events, which, to use the words of Milton, would "vindicate the ways of God to man;" and so it has proved.

We have considered the cost of the ill health of towns; now for that of the remedies. We have seen generally that disease in them is mainly attributable, 1st, to defective ventilation, that is, an insufficient provision for the removal of foul and the supply of fresh air; 2nd, defective sewerage, which allows contamination of the general atmosphere of a place; and, 3rdly, a defective supply of water for carrying off the filth and for washing the house, utensils, food, clothes, and person, and for drinking. All these three, and especially the two latter, are so intimately connected that it is impossible to separate them. How can you ventilate to advantage, if instead of fresh air the open window only admits poisonous gases? How can the sewers be kept clear, or the house or person or clothes clean, without an abundant supply of pure soft water? How can pure water or pure air outside a house benefit the inmates who breathe over and over again the air inside it, and thus impart a frowsy taint to the most scrupulously washed furniture, clothes, and persons? And when the space is too confined that is allowed for the rooms in

Dr. Arnott's Report on the Fevers which have prevailed in Edinburgh and Glasgow, p. 12.

LONDON:
G. J. PALMER, SAVOY STREET, STRAND.

e houses, the houses in the streets, and the streets in the wns, how can light and air reach the inhabitants?

To begin with drainage. The Health of Towns Com- issioners' Reports have shewn that out of fifty of the wns to which these inquiries were directed, in scarcely ne can the sewerage or drainage be pronounced com- lete or good, whilst in seven it is indifferent, and in rty-two decidedly bad, as regards the districts inhabited y the labouring classes. One of the most serious causes of efective drainage, and consequently of widely spreading ources of ill health, arises from the ponding up of water ithin towns for the purposes of navigation, as at York, for the bad effects of which see Mr. Smith of Deanston's eport) and still more frequently for the sake of water ower, as at Manchester, Birmingham, and many other laces at home and abroad. The more usual source of nischief is, either the absence of all sewers or their defec- ive construction; where there are no sewers there are esspools, which act as so many centres for the dissemina- ion of fever: I could quote numberless proofs of this, ut I yesterday heard of one in Plymouth. The house in which my respected friend Dr. Cookworthy lived, was shut up after several deaths had occurred there while a school was carried on it: underneath there was found a cesspool formed by the stoppage of a drain; the accumulation was removed, and the house became healthy.

But where there are sewers, in the great majority of cases they are made too large and flat instead of circular at the bottom—in short, square instead of egg-shaped, with others falling into them at right angles instead of easy curves. The result is, that the action of the water upon all insoluble matter floating within is enfeebled, and deposits are formed. Besides, paradoxical as it may appear, their tendency to choke is increased by their size. No one has half so often known the waste pipe of a water-closet, which is never more than nine inches and seldom so much in diameter, choke, because the water fills it completely, or flushes it as it is called, and then forces along everything whether fluid or solid; besides, in the large drains a most pernicious space is left above, by which the gases pass upwards with a current directly the reverse of that of the fluid, and get through the gratings into the streets. There are several cases mentioned in which houses opposite a grating, especially when on the crown of a hill, have been constantly attacked by fever; from which we learn, that gratings should never be placed on elevated spots, for they cannot serve there to carry off any drain water, be-

cause that has a tendency to descend,—whil
like a chimney to carry up the poisonous ga
the drains, for that has a tendency to ascend
ought to be much less frequent, and contriv
Mr. Smith of Deanston's, or Mr. Foden's,
equally simple plan, to allow a passage dow
water and none upwards for the stink.

This is not all. The brick arches are
and when made small, without proper
being porous, much deleterious matter
them. In all the smaller drains, pipe-
two to twelve inches in diameter, glazed
renders them impervious except at the
be used at a great reduction of cost and
efficacy. Mr. Foden, Mr. Butler Willia
Mr. Biers, and Mr. Guthrie give full p
directions on this subject, in their eviden
Health of Towns' Commissioners. Mr.
a cheap and effectual house drain to b
10*d.* a foot, and Mr. Foden a small drain
or street at 1*s.* 6*d.* The extravagant cos
under the present system of construction
ment in London and other towns cause
tricts to be left unsewered; or even when
are provided, prevent the inhabitants of t
their side from deriving any benefit from
expenses of communicating with the sewer
great, that many forego doing so rather t
heavy charges for being allowed to get rid o
for the sake of their neighbours' health as
own, they ought to be discouraged or even
keep. They are now reluctantly compelled
their filth in cesspools, or discharge it int
Opening a drain into a sewer is in some pla
a crime instead of a duty; it has to be paid f
lege, instead of being required by law as a
which no option should be left.

But indeed no system of sewerage can
which allows the impurities of a town to trickl
in a semifluid state, undiluted, except by occasi
instead of rapidly swept off by a body of w
enough to drive anything before it, in short by
flushing. Dr. Southwood Smith says, that d
water do more harm than good, by diffusi
gases through their gully holes. This can
when the supply of water is copious; and th
to the question of the supply of water gene

old you was inseparable from that of drainage. How
he refuse of a town which is full of the very fertilizing
lements which we have been importing in the shape of
uano, bone-dust, &c., at a vast expense even from the
ntipodes while we let them run into the sea at home;
ow this may be turned into a profitable account and
nake food for us, instead of fever as at present, I will men-
ion presently: but of the 50 towns before mentioned the
Report of the Commissioners states, that in only 6 could
he arrangements and supplies of water be deemed in
ny comprehensive sense good, whilst in 13 they are in-
lifferent, and in 32 they appear to be so deficient as to be
ronounced bad, and so far as yet examined frequently
nferior in purity.

I before said that many towns are hardly supplied at
ll with water—there the inhabitants have to dig wells
or themselves at a vast expense, or draw their supplies
rom public pumps or wells. The waste of labour thus
ccasioned is enormous. I need not do more than men-
ion the long strings of people waiting round the pumps
t Newcastle—or the groups of 20 to 50 standing quar-
elling round the stand-pipes in Southwark—or the way in
hich water is begged or stolen in Edinburgh—or the
egetables boiled without previous washing, and the many
ets of clothes being washed successively in the same
ater, which I saw the other day in London. The fact
peaks for itself. But even where towns are well supplied
s to quantity, the quality is often very inferior. The
ources from whence the water itself is drawn are impure,
r the tanks and ponds in which it is kept are open to
ust and dirt. Now Mr. Hawksley's and Mr. Thom's
vidence shew conclusively that water is filtered at
n extra expense in the working in some places at ½d., in
ome at rather less than ¼d. per 1,000 gallons; which,
llowing 40 gallons daily for the use of a labourer's tene-
nent, would amount to 4½d. a year; or Mr. Genham,
nother witness, says for 3d. Mr. Thom has invented a
elf clearing filter, which cost 600*l*., for the supply of more
han 10,000 gallons daily. Filtering the water in South-
ark Works costs those who use 40 gallons daily 4d. a
ear extra—and this water unfiltered gives 15 inches of
eposit annually.

Not only is it rendered more wholesome for drink, but
etter for steam-engines. I remember myself being de-
ained a long time on a railway because the hottest fire
hey could make could not penetrate sufficiently the

crust of deposit formed in the interior of the boiler by the impurity of the water. Again, it is of the greatest importance to have soft water for washing. Dr. Clark has ascertained that 600,000*l.* of soap is used in London and 300,000*l.* of soda.—At least half this expense would be saved if the water were good, or 315,000*l.* The annual average consumption per head of soap in England is 7½ pounds, costing about 3s. 4d. The water at Manchester is harder than that at London, and therefore wastes more soap and soda. If calculated therefore at 7½ pounds per head per annum, the same as London, that would give an increase of of water-rent to the town of 49,363*l.*

But supposing the water abundant, soft, and perfectly filtered, if the supply is intermittent only, it has to be pumped into cisterns or tanks or water-butts, from which the inhabitants draw it at pleasure. The familiar instance of water getting a taste of paint from standing in a newly painted room shews how freely it imbibes gases from the air. Its affinity for ammonia and sulphur, two elements frequently present in the atmosphere of large towns and close rooms, is notorious to every chemist. In the case of tanks and cisterns even, we have evidence of its getting much deteriorated from this and other causes: but the mass of the labouring classes cannot, or rather their landlords will not, afford anything better than water-butts. Now all the Reports from different towns almost agree in describing these as of wood seldom painted and frequently open at the top. I examined several the other day in London—the wood was half rotten, and there was a sort of rainbow-coloured scum at the top with blacks swimming about in it. The water in these, when exposed to the heat of the sun, soon gets tepid and breeds animalcules or confervæ. How many more water-drinkers would there be if instead of this offensive fluid, pure, cold, soft water were supplied to the dwellings of the labouring classes, night and day, to an unlimited extent up to the highest attic! and yet this may be done for 1d. per week, just 4d. a year more than the common Manchester charge for the use of a pump, which is 1s. a quarter. The sturdy water-carriers get ½d. a pailful at the door—79 gallons can be given for ¼d. in the loftiest garret.

As a proof how much the labouring classes would appreciate such a blessing, as a woman called it to Mr. Toynbee, Mr. Liddle states, that in Cartwright Street they willingly pay 3s. 6d. instead of 2s. a week rent since

r. *Arnott's Report on the Fevers which have prevailed* [illegible]
rgh and Glasgow, p. 12.

LONDON:
G. J. PALMER, SAVOY STREET, STRAND.

their landlord laid water-pipes in each of their houses, though the water is only turned on three times a week. I have not time nor space to enter into the details of the system. I must refer you to Mr. Hawksley's evidence.

But this is not all—the Health of Towns' Commissioners declare it to be essential that the whole of the works for the supply of water, the house, branch and main-drains, should be under one system of management; when that is arranged, it will be found that the fever-breeding cesspool will become an expensive luxury compared with the water-closet. A cesspool cannot be emptied by nightmen for less than 17s. a year. An extra 1d. a week will supersede the necessity for this—2d. a week will suffice for the expense of an unlimited supply of water and for water-closets both. Mr. Foden mentions a cheap form of water-closets which can be put up for 2*l.* or 3*l* for each house, or at 3s. a year extra rent; and Mr. Thorp, an inodorous earthern soil-pan, costing 8s. only, and completely fitted up with a communication to the sewer, duly trapped, for 2*l.*, or ½d. a week extra rent.

Streets can be cleansed and the dust laid and mud carried off cheaper by water constantly at high pressure than by any other means, and fires extinguished withou the aid of engines—for by merely screwing in a hose the water can be conveyed over the tops of the houses. See Samuel Bradley, the Preston fireman's evidence to Dr. Playfair, on the loss occasioned by delay in getting engines and a supply of water to a fire, and the reduction in insurances consequent on the adoption of the improved system. At Preston and Nottingham in this way each house has protection equivalent to 4 or 5 engines kept always at its door for its own exclusive use.

But besides all this, instead of the waste of the town refuse containing valuable manures, these, which now only make fever, can be conveyed to the neighbouring lands in a liquid state cheaper than they can be carted in solid form. Mr. Hawksley says that sewer-water can be raised 200 feet and taken in pipes 5 miles at 2½d. a ton, where there is large demand. It is well known that the rent of some land near Edinburgh has been raised from a few shillings to 30*l.* an acre since it has been irrigated with sewer-water. From experiments made last year in Lancashire, it appears that 8 tons of sewer-water per acre were found superior to 15 tons of farm-yard manure at 4s. per ton, and to 3 cwt. of guano costing 8s. per cwt.

G. LUXFORD, 1, WHITEFRIARS STREET, FLEET STREET.

1848.

Liebig estimates the manure produced b
vidual at 1½ lb. per diem: this would give
tons per annum for a population of 100,000
of animals, the refuse from slaughter-houses
factories, cannot be taken as much less; b
it altogether, taking it as merely making u
waste of the former, we find that 25,000 t
manure, sufficient to irrigate 50,000 acres,
least 12,000*l*., flows into the sea from every 1
population of the Liverpool, London, Glasgo
towns, including, may I not say, Plymouth,
and Devonport.

Now the principal remaining subject i
The evidence of Dr. Guy, who says that th
impure air of workshops, and a similarly
state of the dwellings of the labouring cla
causes of a large number of diseases—of s
eases among children, and inflammation of
the febrile affections to which children are so
of those chronic disorders of the bowels w
terminate in mesenteric disease. This, w
medical evidence I before submitted to y
prepared you for the conclusion to which I
bring you, namely, that the general state of
unsatisfactory and requires amendment.

With regard to ventilation in its largest
of towns, by an improved arrangement of
the expense, I acknowledge, would be for
when it is remembered how many other us
are effected by making streets straight instea
wide instead of narrow, in continuous lin
overhead instead of discontinuous or conne
archways, some expense would not be—in
daily proof that it is not—thought ill bestow
our thoroughfares in large towns not only a
drier, lighter, shorter, and more commodiou
more cheerful and more handsome. Whe
sidered that the breath of human beings alo
of animals, in the metropolis discharges into
tons of carbonic acid and sixty tons of wat
it will be easier to appreciate the importan
of allowing the freest access possible, not
light of the sun, but also to the purifying win
Dr. Duncan, describing the well-like courts
Liverpool, speaks with enthusiasm of the
which he hails a hurricane or thunder-storm

nary breeze has any effect in renovating the atmosphere of spots so completely hemmed in. Indeed, so strongly is the evil of the inevitable deterioration of the air of our enormous metropolis felt, that it is seriously in contemplation to establish villages for the residence of operatives in the neighbourhood of London, from which they would be daily conveyed to their work and back by the railways. The evidence of Captain Vetch as to the best mode of arrangement for the increments of towns is very interesting; as also what he says, and Mr. Butler Williams, on the importance of having accurate surveys made of every town, accessible to all who want them for the purposes of drainage, gas and water supply, &c. He shews the costly blunders and difficulties which result from the absence of such information. It is sufficient to say that additional streets ought to be made as nearly as possible parallel to the exterior lines of the town, with broad continuous communications across them nearly at right angles, and leading straight into the principal thoroughfares.

Now, with respect to the houses themselves, it is essential that they should never be placed back to back, nor even too close to allow of a fairly sized back yard or garden to each, accessible to light and air. With regard to the construction of new ones, I can do little else than refer you to the evidence of Mr. Toynbee and Dr. Guy, and especially of Dr. Arnott and Dr. Reid: the observations of the latter are accompanied by plates, which explain at a glance what it would take many words to communicate.

I will only mention one plan which I have adopted myself in building cottages on the estate which I have the management of, namely, the introduction of some air from the outside through a pipe taken into an iron box at the back of the kitchen fire, whence it is conducted by another tube carried up the corner of the chimney into the bed-room above. In this manner a constant supply of warmed fresh air is furnished to the sleeping-room through a screen of wire gauze, which diffuses it without draught. The extra cost is so trifling that it is not worth talking about. As a general principle it should be remembered that cold air is heavier than hot, and that consequently the breath and steam of the body, as well as the smoke and vapour from lamps and candles, has a tendency to ascend; the great object therefore is to have openings high up in a room. To prove this, Dr. Guy mentions a workshop in two stories without any opening;

in the upper 10 out of 17, in th
15 men working there were affe
chest. Dr. Arnott, on the other
sort of barrack at Glasgow, in whi
a factory lodged, from which fever
was rendered quite healthy by ca
ceiling of each room into the larg
powerful draught of which secure
air for the inmates.

With a view to obviate some of
closeness, for fever as well as sc
Mr. Toynbee and Dr. Arnott have
lators, of which I now shew you sp
(Dr. Arnott's) is to be fixed so a
the chimney near the ceiling. It
the foul air can pass away, but no s
the room through it—it costs 7s.
zinc) is put in the top window-p
fire, and furnishes a change of ai
The third was invented by one of t
to the Working Classes' Health of
which more hereafter. It costs
other only 2s. properly fixed. If t
be put up at once in the same nei
would be less.

I saw myself several of these
The people quite appreciate th
Mr. Toynbee says they are often
than for the flannel, and bread,
them out of the same charitable f

Before I quit the subject of dwe
fer you to Mr. Ward's evidence of t
plants, which consume carbonic
the air in the rooms. But there
same subject, affecting even a la
dwellings do. I mean the ventilatio
and public buildings.

When I read such descriptions
alas! it is no singular one, of a tail
Dr. Guy :—" Eighty men, working
sixteen or eighteen yards long, a
wide, close together, knee to knee
time, what with the heat of the
irons, and the heat of the candles to
higher than the heat outside—the

at tailors from the country faint away in the shop, and isitors complain of the heat and smell as intolerable—the en sitting as loosely as possible, the perspiration stream-g from them. In winter these foul places are still more nhealthy, as the heat from the stoves and candles, and e closeness, is much greater. Cold currents of air treaming in at every crevice—perpetual squabbling about pening windows—the old hands, from long habit inured o the heat, conspiring to stifle the new comers—in the ery coldest nights, the rooms so hot, that large thick allow candles (quarter of a pound candles) have melted nd fallen over from the heat—the young hands unable to ork full time—the old hands losing appetite—thirst aking the place of hunger, and gin of food. Intemperance, n this as in many other instances, a sort of necessity, and ot merely a depraved appetite for a destructive poison:"— cannot help thinking of the contrast presented in the nagnificent factory of Messrs. Horrocks and Miller, hich I went over at Preston, where there are 2000 per-ons employed, and where one single room is about an cre in size. I remember with pleasure the lofty well-ighted spaces, artificially warmed in winter and cooled in ummer, but always ventilated by an apparatus attached o the steam engine: the fittings of the room, which is ay with polished brass and mahogany, where iron and eal would have done if ornament as well as use were ot consulted; but above all, the clean, healthy, happy aces of the work-people, all proud of belonging to an stablishment which their master takes such pains to make omfortable, and is so determined, by excluding all bad haracters, to keep respectable.

I will just mention that it is shewn that a number of hildren, both of rich and poor, become scrofulous in chools, and that the drowsiness and faintness which vercome people so often in crowded churches, par-icularly in the afternoon, proceed chiefly from the car-onic acid gas, which, being heavier, when cool, than tmospheric air, sinks down, when the windows are not pened as they should be, in the interval between the ervices, to the level of the pews below.

As a general rule, no ventilation is of much use in the inter, when the use of light and fires, which consume xygen themselves, renders it doubly necessary, unless the resh air is previously warmed; if it is not, those next the pening will complain of cold, and all will have to be half uffocated to prevent a dozen being frozen.

Before finally quitting the subject of ventilation, I cannot help touching on the kindred one of smoke. The evidence before the Smoke Prevention Committee clearly shewed that in general it can be profitably consumed; but whether this be so or no, when I tell you, on Dr. Playfair's authority, that the annual pecuniary loss to Manchester in extra washing and painting, rendered necessary by the excess of smoke there, amounts at least to 60,000*l.* a year, or double their poor rate, you will agree with me that the law ought to insist on its being consumed.

I have now slightly touched upon the chief remedies for the evils before mentioned, which I proposed to consider, namely, improved drainage, improved water supply, and improved ventilation. I gave you before some calculations of the losses consequent on the ill-health and mortality of several towns. I will just, as a specimen, read you the estimate of the cost of the application of the remedies to the town of Preston, on whose condition I particularly dwelt, side by side with the cost of the present state of things.

[Here several other statistical tables were read respecting the mortality of Plymouth and other towns in Devon-

1.—PROXIMATE ESTIMATE OF EXPENDITURE.

—	Total Number of Houses.	A. Cost per House for Capital.	B. Rent per House	C. Total Outlay.	D. Total increased Rental required defraying by Annual Instalments of Principal and Interest of 20 Years for the House cleansing and Water-Apparatus, and 30 Years for Sewers and Drains.
		£. *s.* *d.*	*s.* *d.*	£.	£. *s.* *d*
1. In want of water	5000	0 10 0	0 6	2500	200 15 0
2. ,, main sewer -	10000	0 5 0	0 2	2500	162 12 6
secondary do.	7919	2 9 6	2 6	19599	1,274 18 9
3. ,, house-drains -	10000	0 15 0	0 9	7500	487 17 9
4. ,, water-closets	10000	2 0 0	2 0	20000	1,606 1 0
5. ,, ventilation - -	10000	0 15 0	0 9	7500	602 4 6
6. ,, street-sweeping	10000	. .	9 3	. .	4,625 0 0

Total immediate expenditure of capital required for the improvement of the town - - - - -	£31,599 0 0
Total increased rental (including the annual expense of street-sweeping) - - - - -	8,959 9 8
Immediate expenditure for each house - -	5 19 3
Total increased annual rent for each house -	0 15 11
Total increesed weekly rent for each house - -	0 0 3⅔
Immediate expenditure per head of the population -	1 3 9
Annual expenditure per head of the population -	0 3 6¼
Weekly expenditure per head of the population -	0 0 0¾ $\frac{13}{54}$

r. Arnott's Report on the Fevers which have pre

rgh and Glasgow, p. 12.

LONDON:
G. J. PALMER, SAVOY STREET, STRAND.

shire and the pecuniary loss caused to the community by the amount of preventible ill health accompanying that excessive mortality in those towns. These have been omitted as superfluous and uninteresting except to a local audience after the full details given respecting Preston.]

Much else there is which I fain would have spoken of, such as the necessity for improved public parks and places for healthful and innocent recreation and exercise, for public baths and washhouses; the latter I need not dwell upon, for in the lectures you will have upon the influence of the state of the skin on health and its important functions, you will be told of the importance of personal cleanliness and frequent ablutions. The public washhouses, I do trust, before long, to see established here. When I know the misery and discomfort consequent on the work of the laundry being carried on in their one room, with no proper appliances for the purpose, with no garden for a drying-ground outside, as in the country —when I consider how the steam and slops make everything damp and mouldy, as well as untidy, I see that the discomfort attendant on the operation must tend either to make them dread it and put it off as long as possible, or else to drive the husband from his home very frequently (for washing makes it quite untenable), to the destruction of domestic comfort. I cannot doubt that some exertion will be made here, in this charitable and public-spirited

II.—PROXIMATE ESTIMATE of Pecuniary and other SAVING from Sanitary Improvements in Preston.

1	2	3	4	5	6	7	8
Saving by one-third of the actual number of Deaths. The expense of each being estimated at 2*l.* 10s.	Saving in the excess of Births beyond 1 in 44 of the Population; the expense of each Birth being taken at 1*l.*	Saving in day's labour from sickness, estimating one-third of the cases out of the expense. — 16,710 Cases.	Reduction by one-half of the existing expense of widowhood and orphanage, the amount taken from the actual expenditure.	Saving in the expense of insurance, by keeping the water on night and day, so as to be in readiness at one minutes notice. Estimated on half the number of Houses at 6s. per House.	Saving of Productive Manure estimated at 10s. per head on the whole Population. All liquid and solid Manure & street sweepings being carried out of Town by the Sewers.	Saving in Washing, &c. consequent on the burning of Factory Smoke. Estimated at 1*d.* per head per week of the Population.	Saving of outside Painting of Shops and Houses; estimating the cost per House at 25*s.*, and the saving at 1-4th of the sum.
£ 1.240	£ 827	£ 7.047	£ 501	£ 15,000	£ 25,000	£ 10.450	£ 1.250

Total annual saving to the town - - -	£47,815 0 0
Total weekly saving to the town - - -	919 10 4
Total annual saving to each house - - -	4 15 7
Total weekly saving to each house - - -	0 1 10
Total annual saving to each individual - -	0 19 1
Total weekly saving to each individual - -	0 0 4½

G. LUXFORD, 1, WHITEFRIARS STREET, FLEET STREET.

1848.

town, to follow the example of London and Liverpool, where these establishments have been in operation most successfully, and where the labouring classes have most gratefully availed themselves of them.

And now, I cannot conclude without a few words on the general question, How came such a state of things as this to coexist with such an advanced stage of civilization as we flatter ouselves we have attained?

When human ingenuity was taxed to the utmost to devise how the greatest possible results might be derived from the least expenditure of means, while communications were being improved, while machinery and the division of labour were being brought daily to a higher pitch of perfection, how came it that, not in remote and ignorant districts alone, but among the very towns, nay, pre-eminently in the very towns where in matters of trade an enterprising expenditure was most judiciously combined with economy—how came it, I say, that such extravagant waste, not only of life, but of money, could be allowed to continue by communities so keenly alive to their own interests?

Besides the greater love of individual independence and freedom of action introduced into all the countries of Europe, by the northern nations, when they overran the Roman Empire and established a new order of things upon its ruins; a spirit of independence which led them constantly to devise means of protection for each man from encroachments, not only on the part of other individuals, but also on the part of the whole community, to a degree quite unknown in the Classical States of antiquity; it seems to me that the other causes are twofold.

In the first place, the political economists and philosophers of the last century having discovered the great errors of preceding systems which had enjoined interference with freedom of action, and freedom of thought to a mischievious extent, flew immediately into the opposite extreme, from the consequences of which we are only just recovering. In making war upon superstition, Voltaire and his school attacked also the holiest truths of our Christian faith; from believing everything men came to believing nothing. So, from a system of omnipresent meddling on the part of the government with trade and with manufactures, with the wages of labour and the employment of capital; from a system of bounties and drawbacks, of prohibitions against usury and penalties upon forestalling and regrating; from theo-

Dr. Arnott's Report on the Fevers which have pre[illegible]
burgh and Glasgow, p. 12.

LONDON:
G. J. PALMER, SAVOY STREET, STRAND.

ries about the balance of trade and the balance of exchange, and schemes for preventing the export of bullion, and encouraging its import, of encouraging the export of their own, and discouraging the import of the goods of other countries; the thinking part of the community went off as far as possible in the other direction. *Laissez faire* became the maxim—everything was to be left to nature—demand and supply, or rather self-interest, was to regulate everything. Private vices were even declared by some bolder speculators to be public benefits. Everything would take care of itself if it were only left to itself.

The mass of mankind adopted just so much of the doctrines of the philosophers as suited their indolence, their prejudices, and their immediate interests. They rejected the doctrines about freedom of trade with other countries, but approved and acted upon that part of the system which enjoined the sufficiency of self-interest to regulate the affairs of the community; and taught that the care, both of mind and body—that education and sanitary measures—would be adequately provided for on the principle of demand and supply. Thus the greatest moral laxity prevailed, while the penal code became daily more sanguinary. The lawmakers cared nothing about vices which only indirectly increased crime and endangered life and property. Debtors languished in prison—criminals died by dozens on the scaffold, and by hundreds of gaol fever; and while the manufactures of England were daily increasing, her children were worked to death without mercy in mines and manufactories, or grew up squalid and ignorant, not having tasted the benefits of education, and, consequently, not valuing it for themselves or for others; there was no demand, and, consequently, no supply.

Happily, as in the worst of times, Christianity continued to bear her testimony to the truth. The labours of Whitefield and Wesley commenced a revival of religion which the labours of others, both dissenters and churchmen, did not suffer to flag. Howard, actuated by genuine benevolence, and unconscious that the soundest political economy and the most enlightened statesmanship would dictate even greater and more costly improvements than those which his Christian love of his bretheren impelled him to advocate,—Howard visited all the gaols in Europe, and died at last a victim to his labour of love; but not before he had enlisted some of the most eminent men, and indeed public feeling, in its favour.

Wilberforce, Clarkson, and their party, moved same horror of injustice and cruelty, and at first u that the material interests of England philosophical sidered were opposed to their continuance, succe abolishing, first the slave-trade, and then slavery British possessions.

The condition of the factory children was inquire and laws passed for their protection.

The severities of the penal code levelled offenders at a time when the rights of property we appreciated; but its duties imperfectly understoo attacked by the virtuous Sir Samuel Romilly, and mitigated by the legislature not less on grounds o diency than of humanity.

Cruelty to animals was made punishable simply b being helpless and unprotected, public sympathy w listed on their behalf.

The education of the poor, at first taken u motives of Christian benevolence, has after an a struggle been distinctly recognised as of the l political importance to the community. Wheth State can advantageously have anything to do with religious instruction or secular education, is a ques know, upon which many fully alive to the value o are much divided; but the importance, the vital i ance of both to the well-being of a nation, and the pensible political necessity as well as the imperative of providing both either from public or private res few now deny.

Lastly,—very much owing to the exertions of my enlightened and benevolent friend, Mr. Chadwick, labours in the cause of humanity will be some day r appreciated—notwithstanding the calumnies he has assailed with—by the labouring classes, who will rec in him one of those real friends who wish to see condition improved and their social position elevate see them educated and independent, and not ignoran dependent on parochial or eleemosynary relief—L the sanitary condition of the people came to be consid and has now occupied the attention of the supreme lature as well as that of many of the corporate and authorities of the kingdom.

All these results had not been brought about wit much discussion. Their effect on the material interes the public as well as their justice and humanity had t considered; and so the seeds of a deeper and truer tical philosophy were sown and are springing up, I trust with God's blessing, to produce much fruit.

Whilst on the one hand we recognise with those who preceded us the folly and mischief of interference by authority, in cases where self-interest affords a sufficient stimulus; we also see that there are many cases requiring combination and concert, with regard to which the old proverb "what is everybody's business is nobody's business," is a safer guide than the principle that men will always do what it is their interest they should do.

Where the consequences of a man's act fall directly and principally upon himself, he will exert himself; but where, as in many instances, the consequences of what each man does are shared by his neighbours equally with himself, the inducement ceases to operate; indeed, such is the selfishness of our nature that with too many the consciousness that another would share the results of labours which he did not partake, is of itself a sufficient motive for inaction.

The golden rule of doing to others as we would be done by would never have led us into such wastefulness and extravagance as what you have seen. If we in the town and country, landlords and tenants, employers and employed, had endeavoured to make the material, moral, and spiritual condition of our neighbours as healthy as we would wish our own to be, we should have found our reward literally here upon earth. I have shewn you the costliness of neglect; but in this as in all other cases we shall be deceived and led astray if we begin in a wrong spirit. If we seek merely that which is expedient, no foresight and calculation will be sufficient to guard us against error. Shrewd calculators enough there have been at Liverpool; but all their shrewdness and calculation have not prevented the waste of hundreds of thousands on ill health. Had one half of that energy and thought been devoted to their duty to their neighbour by that wealthy community, how much richer would they have been! "Seek ye first the kingdom of God and his righteousness, and all these things shall be added unto you."

It is necessary for the authorities to do and prevent much which the self-interest of the individual members would be powerless to accomplish: to keep up armies; to administer justice; keep up police, &c. &c.: but further we have another modification with respect to the general application of the principle, for a long time too broadly laid down that demand regulates supply in the most advantageous manner.

In cases where for the supply of a limited demand, the fixed capital invested bears a very large proportion to what is called reproductive or circulating capital, no effectual competition can take place. Unless the exorbitant charges provoke, or the exorbitant profits tempt, some other party to contend with the original ones for the occupation of the whole or a part of a field not large enough for two, the monopoly is complete, limited only by the willingness of the public to consume at the rate charged, and by the dread of the establishment of a rival party: as the probability of this latter occurrence varies so will the prices; they will fall when the danger is imminent, and be slowly raised as it subsides. If another capital is invested, for a time competition is sharp: but before long the two parties find it their interest to coalesce and to charge the public for a supply produced by the application of two fixed capitals where one would have sufficed for the work, as high a price, on the same principle and subject to the same limitations only, as those which affected the returns upon the original capital.

A Committee of the House of Commons upon the water-supply of the metropolis, reported that the supply of water was not subject to the operation of the usual laws which regulate supply, and that it indispensibly required legislative interference.

The same principle, as you will readily conceive, applies to other things besides water, such as gas, railways, &c.

In earlier times many wants of this kind were supplied either directly by, or under the regulation of, the authorities. Public granaries, aqueducts, fountains, built either at the expense of municipalities or governments, or else presented by the munificence of individuals, attest the recognition of this principle. The principle was misapplied, as in the case of interference with the supply of food; but it still had, as we often find, what Carlyle calls a half-truth about it. The duties of municipalities and local authorities, strong in proportion to the weakness of the central government, were certainly extended very beneficially in those old times to objects of public importance; and the change in the philosophy and political economy of the age is not sufficient to account for the complete abeyance into which, in this country, fell all the powers formerly claimed and exercised according to their limited knowledge by the municipal authorities, the towns, and corporations,

The philosophy and political economy of which I speak affected the thinking part of the whole civilized coun-

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Dr. Arnott's Report on the Fevers which have pre[illegible]
urgh and Glasgow, p. 12.

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tries of the world. Seas and frontier towns cannot, in spite of all the efforts of bigotry and despotism, prevent the interchange of thought between the different members of the universal republic of literature and science. We know that during the feudal ages the condition and manners, the form and practice of government of the corporate towns throughout Europe were very analogous; they owed their origin and progress to similar causes, throughout different countries, in the same stage of civilization and under nearly the same system of government.

If the change in the views of political economists could alone account for this change in the system of government in our municipalities, we should reasonably expect to see a similar change abroad; but this we do not see: and this brings me to the second branch of the subject.

At Paris and elsewhere we find the municipalities actively engaged in providing and regulating for their fellow citizens matters which with us are either committed to bodies specially constituted for the purpose, or left to commercial companies and individuals, or entirely neglected. These bodies have not the whole condition or the town to which they belong under their care—what would have been done by the corporations in the old times as essentially necessary for the welfare of their fellow citizens, and readily acquiesced in by them, did not fall within the scope of the powers entrusted to these bodies, whose functions are strictly confined to certain specified purposes, some of which sometimes bring them into collision with the corporations and each other, as in the case of Liverpool, where there are seven bodies all engaged on business in which they continually clash and interfere with each other. The question here presents itself: Why were these superfluous bodies appointed to perform a part of the natural duties of the municipal authorities, and why were a part entirely neglected?

The answer is, That the corporations had ceased to represent the wants and feelings of the citizens, and therefore had ceased to be trusted by them. They had become a self-elected clique, with interests in many cases opposed to those of the community, instead of being a popular body trusted and looked up to by their fellow-citizens. They had been for years in many respects untrustworthy, and therefore they were not trusted; and being trusted no longer they became untrustworthy in others.

When considering the sanitary and moral condition of our towns, never let us forget how much is due to the corruption of their rulers, to a state of affair

which forced people either to neglect many th
essential to the public interests, or to entrust ther
others than the authorities of the town. Who could
that the state of our sewers, or cemeteries, or lightin
water-supplies would be so bad if the municipal au
rities had for years retained the power and the wi
interfere on behalf of the public in these matters
those of Paris and Frankfort have done and are doing?

At last the old corporations were swept away
lamented, and that great act the Municipal Reform
pregnant, as I believe, with important consequences
undeveloped to the country, established, instead of
elected cliques, representatives chosen by the free
of their fellow-citizens as the municipal authori
But the mischief done could not be at once repaired
consequences will be felt for many generations. Co
ration management had become synonymous with
bery and corruption. In many cases an entirely new
of men, untrained by previous experience in their o
found themselves entrusted with estates charged
the debts of previous civic feasts; in other cases
had little to do but to go to law with other bodies
cially appointed, to execute the functions which, as
porators, they would and might have had in their
hands, but for the bad reputation of their predeces
The result is that civic offices have become rather
tical than municipal. Not being trusted with grave res
sibilities, they have never shewn themselves thorou
capable of undertaking them; and not having sh
themselves thoroughly trustworthy, I do not mean onl
regards integrity but also as regards skill, their fell
citizens have not been anxious to invest them with fu
tions, executed indeed, but at much greater cost and
efficiently, because with less authority, by other bodies.

On the whole it seems to me that the necessary wo
for similar purposes are best constructed by individu
or companies,—for the action of self-interest will ind
them to do it better and more watchfully,—with a
nopoly granted to them for a certain time on cer
terms, after which the works themselves should, as
Birkenhead, revert to the town, or become purchase
by the town for a certain amount, as I think is propo
by a company formed for supplying Glasgow with wa
That afterwards they should either be managed by
corporation, as the gas-works are at Manchester,
better still, be let by public auction by the corporation
parties, either with certain fixed conditions attached

n, at an annual rent to be decided by competition, as lone by the corporation of Paris, which lays down the ns very much lower than ours, and the manner in ch funerals are to be done, and receives from the tractor many thousands a year for this privilege; or to be let at a fixed rent to whatever party will un- take to guarantee the cheapest and best supply to the n.

'hese systems seem to me to combine to the greatest ree practicable the energy and economy observable in lertakings carried on by interested parties as com- ed with public bodies, with due security from unrea- able charges, and ruinous and wasteful competition companies or individuals undertaking for profit works ich are too important to the public, and at the same e too much monoplies in their nature to be advan- eously entrusted unreservedly and for ever to interested ties.

do not say that it is practicable in all cases to apply principles I have ventured to lay before you as those ich, after much reading and thinking on the subject, elieve to be the best in theory. I have only taken the erty of stating them because much diversity and great fusion of opinion appear to prevail at present, from application of certain laws of political economy to es which do not rightly fall within their scope.

After this digression I will sum up in the clear and quent language of Dr. Guy the chief points which I e endeavoured to impress upon you.

1. That in our large cities, and especially in the most wded parts of them, there is an excessive liability to kness, a high rate of mortality, and a great curtailment the natural term of existence.

2. That the classes who are most exposed to these evils the labouring poor and tradesmen, of whom the former fer to the greatest extent; but that the higher classes not entirely exempt from them.

3. That persons of all ages participate in these evils, t that they press most heavily on infants and young ldren.

4. That the diseases which occasion this excessive sick- s and high mortality are chiefly fever and the whole ss of epidemic and contagious disorders, together with ofula and pulmonary consumption.

These four propositions embody the leading facts re- ive to the health and lives of the inhabitants of large vns.

'The following propositions contain a summary of the existing physical condition of the classes who suffer most severely by the diseases just detailed:—

'1. That the districts inhabited by the poorer classes are badly drained and badly cleansed.

'2. That in the houses of the poor there is a great want of all the conveniences which contribute to cleanliness and decency,—an ample supply of water, efficient house-drains, and places for the reception and discharge of refuse matter.

'3. That the rooms inhabited by the poor are overcrowded and ill-ventilated.

'4. That the shops and workshops of the poor are also very imperfectly ventilated, and in other respects extremely unwholesome; and that these evils are often greatly increased by long hours of work.

'5. That in the districts inhabited by the poorer classes there is a great want of open space for exercise and recreation.

'6. That the evils attendant upon scanty supplies of water in the houses of the poor are exaggerated by the want of cheap baths and washing places.

'7. That the several evils enumerated in the six foregoing propositions, and the excessive liability to sickness, high rate of mortality, and curtailment of human life, specified in the first four propositions, stand towards each other in the relation of cause and effect.

'The economic results of the circumstances just detailed are the following:—

'1. Great pecuniary embarrassments among the poor themselves, arising from loss of work or of situation, and the expenses attendant upon unnecessary sickness and premature death. To which may be added the increased contributions to benefit societies, rendered necessary by excessive sickness.

'2. A heavy annual expense entailed upon the community in the shape of large contributions to hospitals and dispensaries, and the general charities of large towns, and of increased assessments to the poor-rates.

'3. A loss sustained by the Government, in consequence of the diminished physical power and greater liability to disease of recruits raised from among the inhabitants of large towns. To which must be added the expenses necessarily attendant upon the crimes springing out of the unfavourable physical circumstances, and consequent moral degradation, of the poor.

'The moral and religious effects of the circumstances already detailed are:—

Dr. Arnott's Report on the Fevers which have prevai[illegible]*burgh and Glasgow*, p. 12.

LONDON:
G. J. PALMER, SAVOY STREET, STRAND.

'1. The sacrifice of self-respect, and the formation of bad habits, among which the vice of intoxication holds a prominent place.

'2. An absence from schools and other places of instruction, from places of innocent recreation and amusement, and from places of worship, from a want of the means of cleanliness, and of decent clothing.

'3. A large amount of crime, directly produced by overcrowding, and the admixture of persons of both sexes, and of all ages, in small and confined rooms.

'The remedies for this fearful combination of evils, physical, economic, and moral, are partly in the power of the sufferers themselves, partly in that of landlords and employers, partly in the power of associations, and partly in the power of government alone.

'The remedies which the labouring class have at their own command are these:—

'1. The disuse of intoxicating liquors, and the careful avoidance of the temptation to drink them under whatever shape it may offer itself.

'2. The disuse on the part of mothers and nurses of Godfrey's cordial, children's quietness, and every preparation of that class, whatever be its name.

'3. Scrupulous cleanliness as far as the means of cleanliness are provided; personal cleanliness by the occasional use of warm baths; daily washing of the entire surface of the body with cold water; washing of the hands after work, and of the face, hands, and feet before retiring to rest; a frequent change of body and bed-linen; and household cleanliness.

'4. The prompt removal, as far as it is practicable, of all slops, and every kind of refuse matter.

'5. The practice of ventilation at all seasons of the year, by opening the doors and windows the first thing in the morning, and thoroughly airing the bed-clothes for a short time before retiring to rest; the introduction into the window of a perforated zinc-plate, or other cheap and effectual means of admitting fresh air, without occasioning too much draft: and leaving the chimney open.

'6. The choice, where it is practicable, of a large and lofty room, preferring the higher stories of the house; and where it can be done without inconvenience, choosing a residence in the suburbs. When there are many in a family, making any sacrifice to secure two or more rooms.

'7. When there is a choice of employments, to avoid sedentary occupations, and those offering the greatest

G. LUXFORD, 1, WHITEFRIARS STREET, FLEET STREET.

1848.

temptation to drink; where there is a
preferring the one whose rooms are larg
tilated, and whose hours of work are
those cases where work may be done eith
the workshop, to do it at home.

'The employer may do the same
scale, and reap the same rewards, by
efficient means of ventilation; by pa
Friday, or on Saturday morning, and
mises; by adopting moderate hours
couraging, or, if he please, insisting on,
of a small part of his men's wages to in
casualties, he will be discharging high du
and enjoy their benefits.

'The things that are in the power of a
stated thus:

'I. To promote inquiries into the actu
tion of the working classes, and the in
circumstances that surround them have
and well-being; to instruct the publi
cheap publications; and to urge on
public meetings, petitions, and all co
the necessity of interference.

'II. A very important kind of associati
these great objects, is an association of th
themselves. Such an association has be
foot, and from my heart I wish it all poss

'I will take this opportunity of in
notice a young society whose Prospectus
into my hands. It is entitled, 'The M
ing Classes' Association for Improving th
and it adopts as its motto a dictum o
"Health is the basis of all social virtues.

'"The working classes in London fe
extremely in mind as well as in body fro
causes, many of which they are confiden
or considerably diminished. Several w
in different parts of the metropolis, hav
into a society which has for its aim th
the public health, and they trust that
operation of their fellow-workmen, and
the wealthier classes, they shall be ab
good.

'"The objects of the society are:—

'"1. To diffuse very extensively, a
classes, by addresses from the committe

meetings, pamphlets, the formation of libraries, and every other available means, information, shewing the evil effects to their health and moral condition produced by bad ventilation, imperfect drainage and sewerage, burials in towns, deficient warmth and exercise, and by a neglect of cleanliness in their persons, houses, and workshops.

‘ “ 2. To point out the most effective and economical means of removing the evils alluded to, by describing plans for ventilation, warming, drainage, and bathing; to state the cost of these plans, and where they can be obtained and seen in operation, and to attempt to get them carried out at as little cost as possible.

‘ “ 3. To use every effort to obtain a more abundant supply of purer water, and to secure better means of carrying away that which has been used.

‘ “ 4. To endeavour to ascertain the sources of impurity in the articles of food and drink in general use, and to adopt measures to remove them.

‘ “ 5. To diffuse among the wives of working men information respecting the best means of nursing, feeding, and clothing their children, and to point out the most efficacious plans for the preservation of their health.

‘ “ 6. To seek assistance in procuring open spaces of land for conversion into public grounds for manly exercises, and by thus securing the means of healthful recreation and amusement among the working classes, to afford facilities for the advancement of temperance and sobriety.

‘ “ 7. To encourage and assist the formation of district societies having objects similar to those of this Association.”

‘ The president of the association is the Right Reverend the Lord Bishop of London; and it has secured the patronage of many men of rank and influence.

‘ III. Another kind of association is that which has for its object not so much to learn, and teach, and influence, as to act. The societies recently formed for building houses for the poor, and that for establishing baths and wash-houses, are of this kind. These effect a great good, partly by doing a little direct good and partly by setting an example. May they be prosperous in both ways!

‘ It only remains that I should say a few words of the power which Government has in this matter. Legislation can do much—very much—so much that no efforts of individuals or associations can avail without its help. We are dependent upon legislation for our supplies of water and the construction of sewers. Unsound legislation may

G. LUXFORD, 1, WHITEFRIARS STREET, FLEET STREET.

1848.

place a thousand obstacles in the way of both, but a good and comprehensive measure may carry these cheap blessings into every court and alley in the kingdom. To legislation, again, we must look for a good system of supervision and inspection, the abatement of nuisances, the closing up of crowded churchyards, the removal of cattle markets and slaughter-houses from the centre of our large towns, the consumption of smoke, the purification of our rivers, and the application of the valuable refuse of towns to its proper use, and, what is doubtless more difficult, the regulation of the hours of work, and the enforcement of ventilation in public buildings, churches, schools, barracks, factories, shops, and workshops.'

I will conclude finally by thanking you for giving me this opportunity of calling your attention to the all-important subject of the Health of Towns. When I undertook to do so I determined to do it honestly and fearlessly; and in order to keep myself as much as possible clear from every temptation to act otherwise, I determined to write this lecture without making any inquiry as to the state of the town of Plymouth, but to give my arguments and state my facts without any knowledge how far any of my remarks apply to the whole or any part of the town I have the honour to represent. For the statistics I have given you are calculated entirely on the same principles as those of Leicester and Bristol from the Tables of Mortality in the Registrar General's Report, and based merely on that. I am glad to see that, according to them, while at Bristol the average age at death is 29, at Plymouth it is 33,—much higher than most of the northern towns, but still, when compared with a higher standard, the figures, particularly those of infantine mortality, the best sanitary test for a town, shew that there is room for improvement.

If I have unintentionally given offence to any one present, I can only say I meant none. If I have used plainer or harsher language than some may think the subject called for, the urgency of the case of the dense population of our towns, their moral deterioration, their social degradation, their sufferings, their death, and their state after death,—the awful weight of these considerations must plead my excuse.

For the imperfect manner in which I have performed my task, my inexperience in writing anything longer than an address or a letter must be my apology.

Dr. Arnott's Report on the Fevers which have prevailed in Edinburgh and Glasgow, p. 12.

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THE

CORPORATION OF LONDON,

AND

SANITARY IMPROVEMENT.

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rom the 'Westminster and Foreign Quarterly Review' for July, 1848.*)*

LONDON:
G. LUXFORD, 1, WHITEFRIARS STREET, FLEET STREET.
1848.

THE
CORPORATION OF LONDON,
AND
SANITARY IMPROVEMENT.

THE questionable policy of excepting the metropolis from the provisions of the Public Health Bill has not had the effect, which was hoped for by government, of diminishing the hostility of interested parties to the most important measure of administrative improvement submitted to Parliament during the present session. In this, as in all cases of proposed reforms, which should be effected with promptitude and decision the moment they are seen to be required, postponement only affords time to those who profit by abuses to organize an opposition, and perhaps to render it effective, by the usual arts of private influence and misrepresentation.

The Corporation of London has taken the lead among the local boards of the metropolis, in exciting the jealousy of the public against the Bill, which it calls an infringement of the "Saxon" institutions of the country, and an attempt to supersede local government by centralization. But although dust has thus been thrown into the eyes of some well-meaning and not otherwise very clear-sighted persons, the mischief effected has not been quite to the extent anticipated. The public have gradually acquired a conviction that the London Corporation, as a specimen of a Saxon institution (if Saxon it be), is not exactly one of which the country has any reason to be proud; and that a little "centralization," or something else that would enforce the reforms which the majority of the Court of Common Council have successfully resisted during the last thirteen years, would not be an unendurable grievance. We need, therefore, hardly do more than explain that the object of the Public Health Bill is not to curtail or limit existing municipal rights, but to extend them. The Bill invests about 300 towns with powers for sanitary objects which they have never before enjoyed, and it guards against the abuse of those powers by giving the rate-payers a power, in certain cases, of appeal to a central board. The Bill, with every other comprehensive enactment that we have yet seen, has its defects of detail, which will hereafter require amendment, and may for the present afford a handle to its opponents, but these detract but little from the general excellence of the principle now for the first time sought to be carried out.

The opposition raised by the local boards of London to the Bill is, of course, only the precursor of a more determined resistance on their part to any measure that may hereafter apply to their own case, a resistance which the parliamentary influence of the London Corporation has often rendered effectual in defeating or marring other schemes of administrative improvement, when of a kind to interfere in the remotest degree with corporate privileges or city government. It may be useful, therefore, to put metropolitan constituencies upon their guard; and, with this view, we will at once address ourselves to the question of *whether the City of London should be excepted from the provisions of any Sanitary Bill intended for the benefit of the whole metropolis?*

The answer to this question is not at all dependant upon any proof of city mal-administration. We will discuss it first upon the assumption (an extreme one certainly) that the city really enjoys a representative constitution worthy of the name, and that its local government is efficiently and economically conducted.

Into what are we inquiring? Into the means, principally, of obtaining the best and cheapest sewage and surface drainage for the metropolis; observe, not for the City separately, and other parts of the metropolis separately, as if the City were as distinct from Finsbury, or the Tower Hamlets, as Birmingham is distinct from Manchester and Liverpool; but into the means of obtaining the best drainage for every street, ward, and parish of London, as parts of one connected whole.

The mystification continually practised by the Corporation, by which they deceive others, and are perhaps themselves deceived, is that of speaking of the City of London as if all London were embraced in the City. Let us note that, on the contrary, the City is a mere fraction of London; its population comprises only 1-15th section of the population of the metropolis at large; and the area of the 110 City parishes occupies less than half the area of the one parish of Marylebone! It follows, that even if the drainage of the city were, for its own interests, best left in the hands of the Corporation, such an exclusive jurisdiction might not be the best for the outlying districts, to be drained by means of the same communications with the river as the city. The Fleet ditch, for instance, which runs through the City from Pentonville, drains an area of 4,400 acres, while the whole area of the City is but 600 acres; so that the inhabitants of the north of London are really much more interested in this one important outfall than the members of the Corporation, or the freemen householders they represent.

We have here, in a short compass, the argument upon which we have to join issue. The Corporation say to the inhabitants of the north of London, the City lies between you and the river, and you shall only be drained with our leave. Whenever you want a new sewer to run through the City for the better discharge of your surface waters, you shall consult us on the subject; and in the mean time, without consulting you, or thinking of your interest at all in the matter, we shall construct our sewers of what form we please, of what capacity we please, and place them at what levels we please!

Should the Corporation enjoy this obstructive power? Is it wise, and for the common interest, that in any part of the Metropolis independent drainage Commissions should exist, acting without concert, and upon different plans?—or is greater efficiency and economy to be secured by unity of system?

The reader, without being very profoundly versed in civil engineering, may easily resolve the problem for himself. Let him ascend to the top of St. Paul's and look round five miles in every direction. He has the district before him. To the south, are the Surrey hills; to the north, the hills of Highgate and Hampstead; between these, the river and the marsh lands of Southwark, Lambeth, lower Westminster, and the Tower

Hamlets. He will see at a glance that the insalubrity of the houses built upon the marsh lands (as yet but partially recovered), arises in great part from the extent of surface water which drains into them from the uplands, and then stagnates. To cure this evil, it will hardly be necessary to point out to him, that the upland water requires, in many cases, to be intercepted, and directed to the river by other channels than those which it at present finds; and that in every case the capacity and position of the main sewers running into the river must depend upon the quantity of water intended to flow into them from the higher levels; perhaps three or five miles distant.

Suppose, for example, the drainage of Islington to require an additional outfall. The dimensions of any new sewer to be constructed for this purpose, to run, perhaps, through Aldersgate-street, must of course be governed by the number of the Islington drains with which it would be connected, and of which the London Corporation has no cognizance. Ought then the jurisdiction of the Corporation to extend to Islington, or the drainage of Islington to depend upon the pleasure of the Corporation? And as the Corporation sometimes pleads its liberality, and indisposition to create impediments to public improvements of any kind, there is still another question. Is it right the Corporation should have the power, for the sake only of maintaining its present patronage, of throwing *upon the owners of City property* the whole expense of the outfalls required for the surrounding districts?

This is the right claimed; the right, first, to make sewers without any reference to the drainage of the outlying districts which may require to use the same communications with the river; the right, secondly, to preserve City patronage at the expense of the City, when, without it, a great saving of expenditure might be effected.

In the storm of 1846, the largest of the city sewers, the Fleet ditch, from the accumulated obstructions occasioned by a sluggish stream, proved inadequate to the discharge of the water which poured into it from a thousand channels. Parts of the sewer were burst open, and Field-lane was flooded. The whole expense of repairs and reconstruction fell upon the city. But as the cause of the damage was not the rain which fell in Farringdon-street, or Bridge-street, Blackfriars, but the torrents rushing down from Pentonville, and Gray's-inn-lane-road, it is clear that the cost of the repairs should have been defrayed, not by the city exclusively, but by the whole district benefited by the same drainage. In the plan proposed, the cost of maintaining the outfalls of the main sewers (the most extensive part of works of this class) would be spread over the whole of the metropolitan district.

We have said enough to show the indispensable necessity of unity of system. For different districts in different parts of the country, different plans of drainage may be adopted; but the metropolis is *one* district, and the whole of its upper and lower levels must be drained upon one plan, or they cannot be drained effectually or without a great waste of means. When the fens of Lincolnshire were drained, nobody proposed to divide the work among the different parishes of Lincolnshire, leaving each parish to set about it in its own way; and yet this is what we were lately doing in the case of the metropolis. We divided it among seven independent boards, or trusts,* acting without concert, and under the direction of different surveyors; each surveyor repudiating the plans of the surveyors of other boards; and the whole of the plans therefore wrong, because having no mutual adaptation to the common object.

In every case of proposed drainage for a large district, four things have to be considered. 1.—The best *lines of direction* for the main channels to be formed, and this must depend upon the flat, hilly, or undulating character of the whole surface. 2.—*Capacity*, in reference to the quantity of water a sewer may be required to discharge; and this must depend upon how much or how little water is to flow into it from surrounding districts.

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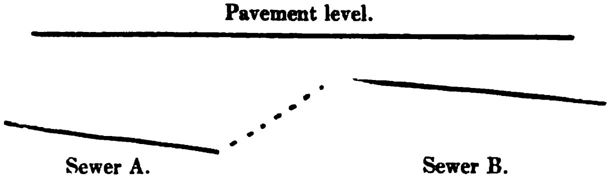
* The 'Civil Engineer,' of February, 1843, describing these different boards, and their operation, says,—

"What is wanted is an examination into all the metropolitan commissions, to see whether they cannot be advantageously consolidated into one body. We have now on the northern side of the river Thames, the City, the Westminster, the Holborn and Finsbury, the Regent-street, the Tower Hamlets, and the Stebon Heath Commissions: here we have six different commissions, which would require months to obtain, even supposing it possible that they should all agree. We have, running right through the very centre of the Westminster sewage, a sewer of a large class, and at considerable depth, constructed about twenty-five to thirty years since, belonging to the Crown, and capable of draining an immense district; yet this sewer cannot be touched by the Westminster Commissioners. Then again we have, as Mr. Donaldson tells us in his report, the Westminster sewers, running from the Thames up Tottenham-court road, to the New road; then the Holborn and Finsbury sewage commences, and after the sewer passes through the latter district, it comes to the county drainage, so that any improvement in the drainage of the uplands of the county could not be made without, first, the Westminster Commissioners constructing a new sewer, or lowering an old one; then the Holborn and Finsbury doing the same. So, also, if either commission wished to divert the upland waters, by constructing catch-water drains, so as to prevent too great a flow down any particular district, and prevent the lower parts of the metropolis from being inundated, it cannot be done, and the consequence is that each commission is obliged to cut about and alter the old sewers, to get rid of the evil in the best way they can."—*Civil Engineer for February*, 1843.

3.—*Levels,* in reference not only to a general fall towards a river, or the sea, but also to the depth at the points of junction of the branch sewers which may ultimately have to be constructed. This having hitherto been very generally neglected,—each board thinking only of its own immediate district,—many of our main sewers can now only be connected with the lateral drain perhaps of an adjoining street, by being made to run up hill, as in the following diagram :—



4.—*Form of Sewer,* in reference both to economy and efficiency as adapted to the flow of water and facilities of junction. A sewer with square sides cannot well be joined on to a circular sewer of the same capacity, and, as all forms cannot be equally advantageous, some experiments should surely have been made, before the days of the Sanitary Commission, to ascertain what forms combine the desired requisities at the least cost.

The diagrams given in the published reports of the Health of Towns Commissioners show the various opinions which prevailed among the old Commissions upon this part of an important practical question, and carry with them a sufficient explanation of the reason why an expenditure exceeding £100,000 per annum should have been incurred upon the sewers of the metropolis, without any result fairly commensurate with the outlay. Think of a million sterling having been actually expended every ten years upon the drainage of the metropolis, and the most important part of the work, the drainage of the bye-streets and the courts and alleys in which the poor reside, having yet (comparatively speaking) to be commenced!

Yet how could it be otherwise upon the system which has prevailed? A system which has suffered the metropolis to be governed, in respect to its drainage, upon the principle of a Saxon Heptarchy—(and this is really all that remains of Saxon about our metropolitan institutions),—petty rival jurisdictions, never acting in concert, pulling different ways for different objects, and eternally quarrelling about their right to a stream or a parish boundary. We have seen each Board of Sewage Commissioners working separately in the dark towards an end which could only be effectually promoted by intelligence and combined action; and the result only a continual doing and undoing; repairing and destroying; improving some neighbourhoods and rendering others worse than before; with sewers converted into elongated cesspools; the reservoirs of pestiferous gases escaping to poison the atmosphere; sewers needlessly large where they are required to be small, and small where they are required to be large; and streets burst open and repaired after a storm, to be again burst open and repaired on its recurrence.

It is not at all necessary we should prove that in any of these respects the inhabitants of the City are in a worse state than their neighbours. The sanitary state of the City might be much more satisfactory than it is admitted to be by the Bill which the Corporation are now promoting for its improvement, and yet our argument would not be affected. When the state of Field-lane was mentioned on a recent occasion, it was thought to be a sufficient answer to say that parts of it were not in the City, although bordering upon it. The answer betrayed an ignorance of the subject in discussion, for it is districts like Field-lane which border upon the City, and can only be drained by sewers which must run through the City, which constitute the whole of the difficulty. Is it well that Field-lane and Farringdon-street should be in the hands of two rival Boards at open war with each other? If the City stood by itself on a hill the difficulty would not arise. It might then be admitted that the City alone should attend to the drainage of the City; but as part of a metropolis fifteen times greater than itself, is there, or is there not, an inconvenience in this divided jurisdiction?

With regard to the health of the City, in its present state, we may observe, that the testimony furnished by Mr. Anderton and the late Dr. Lynch, and recently confirmed by Lord Ashley,* to

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* An appeal having been made to Lord Ashley by the Secretary of the Health of Towns Association, for his Lordship's opinion of the correctness of the statements made by Mr. Tyrrell of the health of the City, the following was the reply:—

"*May 2nd*, 1848.

"Sir.—I have the honour to acknowledge the receipt of your letter, in reply to a communication made to me by the City Remembrancer.

"You appeal to me for any opinion that I can give in respect of the health, cleanliness, effective drainage, and supply of water, in certain parts of the City of London.

"My answer to this appeal need not be long. I entirely concur in the sentiments expressed by Mr. Anderton at a public meeting held in behalf of the widow and children of Dr. Lynch; and am fully convinced that no one of those who gainsay the statements of the advocates of sanitary reform, has ever himself inspected those filthy and unwholesome localities.

"I have perambulated not a few of them in company with a medical gentleman, and I must unhesitatingly offer my emphatic and deliberate testimony, that the language the impurities permitted, has not been exceeded by the evidence supplied of the neglect of sanitary precautions in any other part of the metropolis; and in no other part of London can there be found an equal number of markets, slaughter-houses, and burial-grounds in crowded localities.

The City Solicitor has quoted a return of the Registrar-General, showing, that while the deaths in England are 1 in 46, in France they are 1 in 42, and in Prussia 1 in 37. These figures do not alter the fact that the mortality of the City is greater than that of the average of England, or than the average of the metropolis. The average mortality of the City is 1 in 40, and that of the East and West London Unions 1 in 36 (Cripplegate 1 in 32). The mortality of districts adjoining the City is, for St. Leonard, Shoreditch, 1 in 32; Whitecross-st., 1 in 33; City-road, 1 in 31. The mortality of the more healthy districts of the metropolis is, for St. George's, Bloomsbury, 1 in 48; for St. John's, Paddington, 1 in 56; Stamford-hill, 1 in 63; and Dulwich, 1 in 91.*

Representation.—The members of the Corporation need not be told, however reluctant they may be to admit the fact, that the several Boards of Commissioners of Sewers recently superseded were none of them founded upon the basis of local representation. Mr. Alderman William Lawrence, for example, who has been one of the foremost in the agitation against the Public Health Bill, on the ground of its interference with popular institutions, acted but recently as a Commissioner of Sewers for the Holborn and Finsbury division: and did so as a nominee of the Lord Chancellor; not as the representative of the rate-payers, who had no voice whatever in the appointment. We must be forgiven if we add, that his former position as a Crown Commissioner was a much higher one, and more worthy, in our estimation, of the reform principles he professes, than his present,—sitting as he does for

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and description of the letter you have just addressed to me, fall short of the real abominations which are hourly endured by the wretched inhabitants of those courts and alleys.

"It is affirmed, you say, by some of your opponents, that 'the City of London, for health, cleanliness, effective drainage, and the supply of water, cannot be surpassed.' It may be so; science may, possibly, have done its best in the metropolis of the British empire. Unlearned as I am in these matters, I do not presume to give an opinion on that head. But, if such be the case—if knowledge and zeal can do no more for the physical benefit of these masses of living beings, why, then it is evident that thousands upon thousands are inevitably doomed to a disgusting and hopeless degradation.

"I am, Sir,
"Your very obedient, humble Servant,
(Signed) "ASHLEY.'

* Fifth Annual Report of the Registrar-General.—p. 468.

one of the most rotten wards in the City. The predecessor of Mr. Alderman Lawrence was Mr. Alderman Hughes Hughes, who was returned for the ward of Bread-street in 1844, by the votes of 32 resident freemen, his opponent having obtained but 31; and there has since been no contest.* Such is the constituency for a public functionary, who, by virtue of his office is a member of the Commission of Sewers for the City, a magistrate for life, trustee *ex-officio* for numerous public charities, and Lord Mayor by rotation.

We yield to no man in a respect for the true principles of local representation; municipal councils fairly elected by the rate-payers are for a thousand reasons better than government boards for local duties; but is the nomination of 32 freemen in one ward, or even of 300 in another, to offices such as the above, affecting the interests, directly or indirectly, of a population of two millions, to be preferred to that of a responsible minister? We think not. Of all forms of government that of mock representation is the worst. Despotism is bad, but mock representation is despotism without its honesty; despotism in disguise; ambition without the courage of force, attaining its ends by cunning.

Although several attempts, and some recently renewed, have been made to get the City franchise extended to rate-payers, they have hitherto always failed. The elections continue in the hands, not of the rate-payers but of the freemen, and the wards (the electoral districts) are so arranged that the smallest wards return the majority; so that the Corporation, instead of representing the City at large, with its population of 129,000 inhabitants, is really a petty oligarchy, *representing the minority of a minority.*

The statement, therefore, that, under the existing system, those who are called upon to pay sewers' rates have a voice in the disposal of the money, is at variance with the fact; and this will be the more evident when it is remembered that the sewers' rate is a landlord's tax, deducted by the tenant from his rent, (excepting in cases of special agreement); and as in city corporate elections the resident freemen only vote, and the owners of house property are for the most part non-resident, it is clear that the parties chiefly interested can have practically no control whatever over the funds to which they are compelled to contribute.† Is it that no control is required? May unlimited confidence be safely placed in the honest and economical administration of the Corporation as the trustees of the public? We will inquire a little into this fact. But first let us examine the claim for support set up by the City Commissioners of Sewers on the score of *gratuitous services.*

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* It is understood, however, that this constituency has since been somewhat enlarged, but not amended, by the creation of votes on both sides. This is done by paying the freedom fines and fees (about £11), for those who cannot find the money, or are indisposed to raise it.

† We may give here, from our own knowledge, the case of an owner of

Their services are not gratuitous. It is true the Commissioners do not receive salaries; but salaries are not the only mode of payment. There are three modes in which every member of the Corporation is paid.—1. In the invitations which he accepts, and even claims as his right, to festivities, of which the cost often extends to £1,000 for a single dinner, at the expense of his fellow citizens. 2. In his share of an amount of patronage greater than is enjoyed by any member of the House of Commons, Her Majesty's ministers excepted;—there being in the gift of the corporation no less than 263 places of which the emoluments exceed £100 per annum; 60 of which the emoluments exceed £400 per annum; and 21 of which exceed £1,000 per annum!* 3. He is paid by those opportunities of influence which enable him to secure some one of these offices for himself if it should suit him to accept it at the time of its being declared vacant. We need not mention the many instances of old members of the Corporation (the names of some of them as once busy reformers will occur to the reader), now holding salaried offices under the Corporation, and who in this way have at last found the means of remunerating themselves for their former (so called) honorary labours as the Corporation Commissioners of Sewers.

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house property in the city, a non-freeman. He was about (in 1843) to pull down and rebuild a block of houses, forming the corner of Whitefriars Street, Fleet Street, having a frontage of 200 feet. These houses, although burdened with sewers' rate, drained only into cesspools, and he therefore memorialised the City Commissioners that a sewer might be made. The application was granted on condition of his contributing £100 towards its cost; which was paid. When the sewer was completed, he expected to be allowed to use it free of any further expense, but was charged £3 19*s.* for each of the house drains leading into the sewer. These drains were so laid by the Commissioners that the new buildings were presently filled with rats from the Thames, and the owner had then to incur the further expense of traps to keep them out. The amount of the sewers' rate which continues to be collected from the same property would have enabled the new Sanitary Board to have taken upon itself the entire cost of the sewer and house drains, without any additional charge to the owner (Mr. W. E. Hickson). The inquiries set on foot by government into exactions of this class, and their exposure, have since induced the City Commissioners to give up their system of forced contributions in similar cases to the above.

* The particulars of these are given in the number of the 'Westminster Review' for March, 1845.

Let us look at the expense of one of these offices. The amount of the sewers' rate, when received by the collectors in their several districts, is paid into the hands of an officer called the Chamberlain. How much is he paid for taking care of the money? The following is the present cost of the office, as fixed by a resolution of the Court of Common Council, September 14th, 1843.

CHAMBERLAIN.

His emoluments not to exceed *	£2,500	0	0
For his clerks	2,102	10	0
	£4,602	10	0

Mr. Tyrrell, the City Remembrancer, has addressed a letter to Lord Ashley, in which he challenges inquiry into the existence of any jobbing on the part of the City Commissioners, and concludes with stating that the Health of Towns Association, of which Lord Ashley is a member, have been "made the tool of parties who have in view objects very foreign to the promotion of health, cleanliness, and morality, being nothing less than their own personal advancement and aggrandisement, at the expense of the liberties and rights of others!" The City Solicitor, in the same spirit, describes the Public Health Bill as one to "make small places for small people."

The parties who prefer these accusations should at least have clear notions of what the term "jobbing" means, and should be quite certain, that whatever may be their own integrity of character, the men and the system they defend are free from the imputation they would fasten upon others. Let us drop the term "jobbing," as needlessly offensive, but pursue this part of our inquiry a little further.

The City Commissioners of Sewers, being in fact merely a committee of the Court of Common Council and Court of Aldermen, have, in the case of all legal difficulties that may arise, the assistance of the legal staff of the Corporation. What is the cost of this branch of the public service in salaries, fees, and other emoluments? Not less than £35,000 per annum! The return furnished by the officers themselves in 1833, of appointments held by solicitors, barristers, proctors, and attorneys' clerks under the Corporation, amounted to £38,067 19*s.* 6*d.*; and it has since not undergone a reduction of 5 per cent.

It will not be our business to show that any of these gentlemen are over-paid in reference to their high individual merits.

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* These emoluments are derived from balances. The chamberlain lending the corporation their own money at interest, or advancing it to other parties on security.

The eminent services of the Recorder, for example, he being not only a clerk to the Court of Common Council, but a judge in the City Criminal and Civil Courts, may be cheaply secured by his salary of £3,000 per annum; but what we desire to know is, how it happens that a smaller number of officers possessing high professional talent is not made to suffice for the whole of the somewhat narrow routine of duties belonging to municipal government.

Let us take the four offices of the City Remembrancer, City Solicitor, Comptroller, and Town Clerk, the duties of which are analogous, as connected with rents, leases, assignments, tolls, the defence of corporate rights, bills to be promoted or opposed in Parliament, &c., and which in the new Corporations created by the Municipal Reform Bill of 1835, as well as in the Poor Law Unions, are all comprised in the duties of the one office of Clerk to the Board.*

REMEMBRANCER.

Salary	£1,000	0	0	
Allowance for Office Expenses	250	0	0	
Allowance for business done in respect of funds created by Act of Parliament	595	2	5	
Allowance for the business of Deputy Registrar, including £155 4s. 8d. for Office Expenses	277	10	6	
				£2,122 12 11

"An office is provided for the Remembrancer by the Corporation. The Remembrancer is entitled to one buck and one doe annually out of His Majesty's parks or forests."

(Signed) E. TYRRELL.

COMPTROLLER.

Allowances from City cash :—

Formerly, £866 11s. 2d., but reduced in 1841 to ..	£ 200	0	0	
Leases, assignments, licenses, fees, &c. paid by the public, according to the return furnished in 1833, by Mr. F. B. Hookey	742	17	4	
From Act of Parliament funds (see the same returns) ..	1,714	13	8	
				£2,657 11 0

(Subject to Office Expenses) £662 14s. 6d.

"In addition to the above, a house and taxes are provided at the expense of the City, and a coach-house and stable in the City Mews; and also an allowance of coals and candles for the use of the offices; there is also an allowance of £55 per annum for books and other stationery."

(Signed) F. B. HOOKEY.

TOWN CLERK.

(As fixed by the "Officers' and Clerks' Commitee," in their report, dated May 6th, 1842).

Authorised fees, which, as estimated by the committee, produce an average sum of ..	£1,100	0	0	
Allowances from City cash	200	0	0	
From Act of Parliament funds	700	0	0	
Carried over	£2,000	0	0	£4,780 3 11

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* The practicability of their consolidation may be inferred from the fact that the City Solicitor acted for the Comptroller for several weeks on the last vacancy occurring by death, and is not now so overburthened by his official duties as to find himself incapacitated from representing the borough of Lambeth in parliament.

Brought over……	£2,000 0 0		£4,780 3 11
"Besides the advantages of an official residence, with the usual allowances in respect thereof."			
Allowance for clerks and stationery ..	1,500 0 0		
Life Assurance for the chief clerk, in addition to his salary of £500	200 0 0		
Fees to clerks, which in 1844 produced ..	117 0 0		
		£3,817 0 0	
Additional Establishment.			
Reader to the court	£100 0 9		
Deputy Registrar	200 9 0		
Clerk	100 0 0		
		400 0 0	
			£4,217 0 0

CITY SOLICITOR.

In a recent address published by Mr. Chas. Pearson, the present City Solicitor, in defence of his consistency as a reformer, he says:—

> "By close attention to the duties of my office I have been enabled, with my salary and other emoluments, to raise my income to £2,110 a-year, that is the amount of the income which I returned under the Property Tax assessment."—(Page 201.)

The amount paid to his clerks and for expenses of offices, not included in the above, is not stated, but may be assumed, judging from the office expenses of the Town Clerk, to be not less than £890. This will make the total expense of the office to the public agree with the estimate of 1833.

Salary and other emoluments	£2,110 0 0	
Clerks and office expenses	890 0 0	
		£3,000 0 0
TOTAL EXPENSE TO THE PUBLIC OF THE FOUR OFFICES		£11,997 3 11

In this country we are accustomed to great anomalies; but one of the most extraordinary lately witnessed has been an agitation against government patronage, under the virtuous pretext that the Commissioners of the Public Health Bill were to be paid, and got up by the very men who participate in the above abuses. If public servants should not be paid, the argument would of course apply most emphatically to the City Remembrancer, and the City Solicitor, whose services, however invaluable, are at least not gratuitous. But what is more extraordinary still is the fact, that government should be so far impressed with the force of this disinterested reasoning, as to have proposed that the office of Commissioner under the Bill should be entirely honorary. Upon the remonstrance, however, of some earnest reformers in the House, it has been agreed that one of the Commissioners of the Central Board shall receive a salary not to exceed £1,500 per annum. Shall we take this as a fair test for the remuneration of official labour? If £1,500 per annum be a sufficient sum for the expense of a department that is to superintend, for sanitary objects, the local Boards of all England, how much of the above £12,000, for a fraction of the business of one only of those local Boards, is misapplied?

We will not here reproduce the particulars of other offices in the gift of the London Corporation, which were given at length in the March number of the 'Westminster Review' for 1845,* but the following summary of the whole cannot be too frequently laid before the public:

PATRONAGE OF THE LONDON CORPORATION.

A statement of the cost to the public, in the year 1833, of the officers and clerks of the London Corporation, in salaries, fees, and office allowances, from returns signed by the officers themselves, and presented by them to the Revenue Committee of the Court of Common Council in 1835.

Legal Staff, (Consisting of appointments held by solicitors, barristers, proctors, and attornies' clerks)	£38,067	19	6
State Officers, (The Lord Mayor, Chamberlain, Sheriffs, Yeoman, Trumpeters, &c.)	24,187	2	9
Officers of Customs and Market Dues	29,338	12	8
Officers of City Gaols	4,330	7	2
Officers of Public Works	5,403	12	5
Miscellaneous Officers, (Including Hall-keepers, Beadles, Irish Society, Port of London, &c.)	9,653	5	4
	£110,980	19	10

The above does not include the patronage arising from the City Police, the cost of which is £45,000 per annum, (£20,000 per annum more than the charge would have been if consolidated with the Metropolitan Police), nor much incidental patronage of a kind not necessary to particularize †. Contrast this return with the expenditure of the Municipal Corporation

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* Reprinted as a Pamphlet, under the title of 'City Administration,' No 3. Price 6d. Sold by G. Luxford.

† The aldermen are trustees, *ex officio*, of the Royal Hospitals, and various other charity estates; and the following items should be added to the patronage of the two courts:—

Ten City Tradesmen's Bills for various purposes.			
Patronage of Eighteen livings.			
Pensions to Aldermen's Widows and Children, and others who held offices under the Corporation	£2,793	18	0
Pensions to Coal Meters	17,011	7	0
Committees of the Common Council for Tavern Bills, Summer Excursions, &c.	6,584	16	9
Expenses of City Barge, for do., do. (average of seven years)	453	5	7
Fitting up Guildhall, and stopping up streets on Lord Mayor's Day (average of seven years)	529	12	10
	£27,373	0	2

of Leeds which, for the year 1843, was but £21,464 10*s.* 11*d.!* including the administration of justice, expense of gaols, police, county expenses, and salaries of every kind.

Reform is a plant of slow growth, but if we may judge by the impulse it has lately received, the reign of corporate extravagance, and exclusive privilege, must soon have an end. Let it, however, be well understood, when the time comes, that the mal-administration of the Corporation of London is only a part of a very wide and important question,—that of the best constitution fitted for the municipal government of the whole metropolis; a subject upon which no city reformer, if in any way connected with the Corporation, can be trusted; however honest or unprejudiced he may be upon other topics.

The reformers of the Corporation appear to have the same notions of liberty as Barbés, Blanqui, Hubert, and the rest who the other day sought to overturn an assembly elected by universal suffrage, that they might govern France in their own way. The privileges claimed for the Corporation are not the rights of equals, but the authority of superiors, amounting to an intolerable usurpation; and although of late a disposition has been shown by a growing party in the Court of Common Council to extend the municipal suffrage, this is not with any idea of surrendering an atom of their power of interfering with and restricting the rights and privileges of the rest of the metropolis. The members of the Corporation claim:—

1. The right of taxing the whole of the inhabitants of the metropolis without their consent, and of applying the money without consulting them in any way on the subject. This power is exercised in tonnage charges upon shipping, in duties upon coals, corn, wine, potatoes, fruit, oysters, &c. landed from the river, or, in the case of coal, coming also to London by canal, road, or railway. Of the duties on coal 8*d.* per ton are levied by Act of Parliament for the approaches to London Bridge, and some street improvements effected at the west end; but the duty of 4*d.* per ton, producing about £50,000 per annum, is claimed by the Corporation as a kind of private property, and is included in the accounts of what is called the "City Estate."

2. The right of exemption from the county rate in consideration of their defraying, with a portion of the above money, the expenses of the city prisons and of the Central Criminal Court.

3. The right of regulating the navigation of the River Thames from Staines to Yantley Creek; and right to the property in the soil on both banks of the river, which they are now disputing with the Crown in the Court of Chancery.

4. The right of diminishing the security of person and

property, by setting up, in the middle of the metropolitan district, a rival police administration; to the advantage only of the depredator, who profits by the want of unity of action between the two establishments.

5. The right of appointing the Judge of the Central Criminal Court, the High Bailiff of Southwark, &c., and right of the exclusive management of the prisons of Newgate and the Compter,—affecting the administration of justice for the whole of the metropolitan circuit.

6. The right of holding a cattle market in the city without consulting the inhabitants of the metropolis, generally, upon the inconvenience of allowing horned beasts to be driven in the daytime through its most crowded thoroughfares.

7. The right of slaughter houses in narrow lanes, and of an exclusive control over the outfall of the drainage area of the whole north of London.

8. The right of maintaining the pomp and state of Mansion-House festivities out of a fund to which the whole of the inhabitants of the metropolis contribute by indirect taxation; and this right for the petty exclusive distinction of dining with her Majesty's ministers and other public functionaries on state occasions.

We repeat, that men who can put forward these claims and insist upon them, whether they call themselves reformers or conservatives, have no true respect for the principle of self-government; or no exact comprehension of its signification. What they mean by liberty is really a dictatorship. They assume powers for a section of London, which, where they should exist at all, should only belong to the whole of the metropolis, as *one municipality*. The spirit of their assumption is precisely the same as that of the "*Ouvriers*" of the Faubourg St. Antoine, who recently, as in the days of the first French Revolution, have sought to conquer Paris, for a government of their own.

To form the metropolis into one municipality, and to supersede the multitudinous local acts relative to bye-laws which now exist, by an uniform code, the plan we have advocated has been that of giving to the ratepayers of the city and each of the metropolitan boroughs the power of electing a town council, and of uniting the whole of these councils, for general purposes, by an upper chamber chosen from amongst themselves. A consolidation of interests effected in this way would supersede the necessity of all metropolitan Commissions. But, from what we have seen of the difficulty of effecting such an arrangement, we believe that, for the present, Commissions are the only practicable palliations of the existing evils. And observe, the objections raised are not to the principle of Commissions of government appointment (which might be obviated by ultimately making them elective), but to "centralization," in the sense of that consolidation of public business which, with or without representation, is alone the remedy for wasteful expenditure. No matter how extended the elective franchise, any plan of local reform that would involve the "rolling into one" such offices as the four we have named—of the Remembrancer, the Comptroller, the Town Clerk, and the City Solicitor—would be denounced in certain quarters as "centralization" of the most dangerous kind. And the clamour would not be confined to the holders of these places, nor their expectant possessors in the Corporation. Out of the Corporation the principal cause of the heavy expense of the local rates of the city is its minute parochial subdivisions. The entire area of the city being smaller than Marylebone, which has but one vestry, the whole of its parochial business might be conveniently and economically transacted by such a body as the Court of Common Council, if properly constituted; but any such scheme would be denounced as "centralization" by eighty-five separate juntas, and the host of their dependants, profiting by the existing distribution of parochial patronage.* Carry, out of the city, the principle of reducing the number of local functionaries, and the twenty-one paving boards of the parish of St. Pancras, that might, in like manner, be consolidated, to the great advantage of the rate-payers, would equally and energetically protest against the centralizing operation to which they would be subject.

The aggregate amount of the wasteful expenditure caused by the present complicated state of the local organization of the metropolis, has had no parallel in the history of municipal administrations.

A stranger in London, taking up his abode in the city, ignorant of its customs, has not been there a year as a resident before he is startled by the frequency of the applications made to him for heavy local rates—consolidated rates, sewers' rates, ward rates, poors' rates, church rates, &c. Summing them up, he finds that they equal the rent of a handsome house in the country, and that they exceed, by about one-half, the average amount of the local rates of the rest of the metropolis. He learns that the local rates levied in the city (exclusive of government taxation, and the indirect taxes levied by the corporation upon coals, corn, &c.), amounted, for the year 1842, to £230,000. Imagining this, perhaps, to proceed from the poverty of the city, what is his astonishment when he is told, upon the authority of the Charity Commissioners, that the city possesses an hereditary revenue of £360,000 per annum, originally bequeathed for the same class of objects for which the local rates are required—namely, the relief of the poor, the cure of the sick, education, religion, and general purposes. He learns that nearly the whole of this immense fund was once held in trust for the public by the "mayor, aldermen, and commons of the city of London;" but that, from the corruption which prevailed in past times, this revenue has gradually been permitted to slip out of the hands of the Corporation into those of bodies practically irresponsible, and who so administer it as to deprive the public of all but the minimum of the benefit it was intended to confer. He learns that the Corporation now, so far from exerting itself to check in other bodies the misapplication of charity funds, sets itself an example to all other trustees throughout the country, of unbounded waste and prodigality; not only multiplying unnecessary offices, but rewarding their holders with emoluments exceeding the salaries of ministers of the crown, and supporting a town mayoralty at a greater cost than that of the president and secretaries of the United States Government.* He discovers that the contagion of this example, extending more or less to every branch of local administration in the Metropolis, and the proceedings of the two hundred independent Boards to which its administration is entrusted, being separately too insignificant to attract the attention of the press, an annual revenue of THREE MILLIONS sterling, raised within the circuit of the Metropolitan Police district (including the City), is frittered away without the public knowing any thing of the matter, and proves inadequate to the local objects to which it is professedly devoted;—that education is still wanting for the children of the poor, and that public baths, street improvements, river embankments, and a multitude of works of public usefulness linger for want of funds, and have to be ultimately abandoned.

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* Some of the 110 city parishes being united, the number of separate parochial jurisdictions is reduced to eighty-five. These have been combined, for poor-law business, into three unions; but there are still eighty-five independent staffs of parish functionaries acting separately in the administration of trust property, church-rates, &c.

No honest and unprejudiced mind can consider these facts without arriving at the conclusion that the chief cause of the whole mischief is to be found in *divided jurisdictions*. Leeds, York, Bolton, Manchester, every other municipal town, has the power of exercising some general supervision of its own affairs. The Metropolis has none. It is like a house without a landlord, or with a separate landlord to every room. Unity of administration, without which there can be neither efficiency nor economy in the local government, is as necessary for London as for Leeds, and infinitely more so, because the interests affected are of far greater magnitude.

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* The cost of the city mayoralty, exclusive of the expense of the justice room at the mansion, is about £20,000 per annum. The City Solicitor says £10,000 per annum.

This is not "centralization" in the obnoxious sense of the term. It is well to hold in abhorrence that kind of centralization which recently existed in France, when the leave of a minister had first to be asked and obtained for almost every municipal act; a system which practically put a stop to all progress: but the abuse of the powers of a national executive is not a rational argument against their existence. The abuse in France consisted, not in rendering local Boards responsible to the National Executive, as they always should be, for a violation of the laws, but in practically depriving the local Boards of all power, whether for breaking the laws, or acting up to their spirit. In fact, under the government of Louis Philippe, local government could hardly be said to exist. The true principle is to allow to municipal councils perfect freedom of action, but freedom of action subject to responsibility, when laws are broken, or duties neglected; and there can be no efficient responsibility without supervision.

Nobody, that we are aware of, wishes to revive the French system (now expiring) in England. The cry of "centralization," got up against the sanitary and other local reforms proposed to be effected, has but one and that a very obvious meaning,—"This, our craft, by which we live, is in danger." The ratepayer of the Metropolis, if he understands what he is about, will answer it by another;—"Keep your hands out of my pockets."

⁂ For a brief summary of the local revenue of the Metropolis, see the following page.

LOCAL REVENUE OF THE METROPOLIS.

THE CITY.

Trust estates for public objects administered by									
Chartered companies	£ 85,685	18	8						
Parishes	38,703	8	6						
The Corporation of London ..	110,943	9	2						
The Five City Hospitals .	128,763	15	5	£264,096	11	9			
Coal Duties. (Returns for 1841, since increased).									
4*d*. per ton on account of "City Estate"	48,521	17	2						
8*d*. per ton on account of "London Bridge Approaches Fund" ..	96,232	11	10						
1*d*. per ton on account of the Coal Market Fund	12,022	2	11						
	156,756	11	11						
Deduct drawbacks ..	3,869	2	6						
				152,887	9	5			
Metage duties on corn, fruit, potatoes, salt, &c., with street and market tolls, at least				50,000	0	0			
Freedom and livery fines, fees, and other charges of the corporation and trading companies, about				50,000	0	0			
Tonnage dues, and other charges connected with the Port of London, and conservancy of the river, about				60,000	0	0			
City poor's rate, police rate, consolidated rate, sewers' rate, ward rate, &c. (1842)				230,000	0	0			
							906,984	1	2

METROPOLITAN POLICE DISTRICT.

Police Rate, P. R. 88: (1841)									
Received from parishes	£182,257	6	7						
" the treasury ..	102,229	1	9						
				284,484	8	4			
Poor's rate for the same district, about one-half more than the cost of the police; say				426,726	12	6			
County rates (say the proportion to the police rate in Marylebone, which is one-half)				142,242	4	2			
Church rates, &c. (say the proportion to the police rate in Marylebone, which is also one-half) ..				142,242	4	2			
Paving, watering, and cleansing rates (the proportion to the police rate in Marylebone is about equal)				284,484	8	4			
Lighting (about one-half)				142,242	4	2			
Sewers' rates (the expenditure in 1833 not including the City)				100,000	0	0			
Metropolitan roads (P. R. 388)				71,596	11	4			
Charity funds in Westminster, and the four metropolitan counties of Kent, Middlesex, Surrey, and Essex				148,649	5	7			
							1,742,667	18	7

Total local revenue of the metropolis (approximate estimate)	£2,649,651	19	9

Waterlow & Sons, Printers, 66, London Wall.

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Compts

OBSERVATIONS

ON THE

BRITISH MUSEUM, NATIONAL GALLERY,

AND

NATIONAL RECORD OFFICE,

WITH

SUGGESTIONS FOR THEIR IMPROVEMENT.

BY

JAMES FERGUSSON, M.R.I.B.A.,

AUTHOR OF "AN HISTORICAL INQUIRY INTO THE TRUE PRINCIPLES
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CONTENTS.

PAGE
INTRODUCTION 3
BRITISH MUSEUM 13
  THE LIBRARY 15
  SCULPTURE GALLERIES 20
  NATURAL HISTORY DEPARTMENT 27
  COURT YARD AND PORTICO 29
  EXPENSE 33
  IMPROVED FORM PROPOSED 39
THE NATIONAL GALLERY 48
RECORD OFFICE 50
PROPOSED IMPROVEMENTS 56
NEW NATIONAL GALLERY 66
APPENDIX 79

DIRECTIONS TO BINDER.

PLAN OF BRITISH MUSEUM TO FACE PAGE 15
PLAN OF NEW NATIONAL GALLERY 68

INTRODUCTION.

There are few subjects which have recently engaged so much of the earnest attention of thinking men, as that of education, taking that word in its widest sense—not only as teaching boys and girls to read and write, but as comprehending also the far more important question of instructing the minds of full-grown men, and improving and refining the tastes and feelings of all classes. So recently, however, has the question been taken up, in this latter sense, and so manifold and deep-rooted are the prejudices with which it has had to contend, that few questions have given rise to greater diversity of opinion, and on scarcely any one does there appear to be such a lack of sound general principles or of comprehensive views based upon them.

Of the implements (if I may use the expression) useful towards bringing about a better state of things, none have attracted more general attention than the establishment of public libraries of reference, museums of natural history and curiosities, and galleries of pictures, statues, and other objects of art; and not without reason, for none seem to promise more fruitful results—when their objects are understood, and they are properly applied, to advance the great aim of national education.

For my present purpose it will suffice to consider the object of these institutions as threefold.

First, as established for the purpose of assisting the studious and scientific,—those who devote a great portion of their time to this object,—in the prosecution of their researches, so as to enable them to react on the masses by improvements in knowledge, and consequently a higher class of instruction; or to improve the taste of artists, and give them hints for improving their dexterity in execution and power of expression.

A second object of great importance is to enable those who have neither the leisure nor the disposition to attempt the laborious task of marching in the van, and leading their fellow-men; to attain by casual inspection, a knowledge of what has been done in science and in art, so to obtain a certain amount of information and improvement of taste, by mere familiarity with results, without wading to them by the more laborious process of studying the means by which these results were attained.

A third object of these establishments is, or ought to be, the instruction of the higher classes of students, whose education ought never to be considered complete till they know all the more important results of scientific research, and are familiar with the triumphs of art in every branch.

The first two of these are the only objects aimed at in our metropolitan institutions, and these only somewhat blindly and imperfectly; whether or not we shall afterwards be able to add the third, will depend mainly on the position the London University may be able to take hereafter among our national institutions. I trust it will be a high one, but it has yet a long and struggling career to go through, before it can hope to attain it.

The only places in this country where all three might have been successfully attained, are the sister Universities of Oxford and Cambridge. I need scarcely add they have rejected and ignored them all. With the innate indolence of monastic establishments, they have been content to confine their knowledge of art to its verbal form, and to a small, isolated, and extinct branch of even that one form; and their knowledge of science to one branch of the most formal and, consequently, the least suggestive of the sciences. Progress they ignore and detest. Yet, had they followed her guidance, they might with their enormous wealth, and in the centre of the freest and widest-spread nation of the earth, during the undisturbed leisure of centuries, have accumulated such stores, for the elaboration and advancement of science and of art, as would have made them the loadstars of the world, and this nation the model and the prototype of the intellectual, as she is of the political institutions of the world.

Instead of this they have been content to conduct the education of the select few entrusted to their charge on the narrowest and most limited basis, adopting the standard of a bygone and semi-barbarous age; but though they have thus succeeded in keeping back the upper classes to their own level, they have not been able to hinder the progress of the middle and lower classes, who are beyond their ever narrowing influence; and it is because these classes have become aware that there is something which our mediæval universities will not give us, but which we must have, that they have demanded those institutions regarding which I am about to write; however unwilling Government has always shown itself to foster the movement, the pressure from without has been too strong and a good deal has already been done, though much more still remains to be accomplished*.

Unfortunately the classes who are most beneficially interested in the movement have neither the knowledge nor the leisure to enable them to grasp it as a whole, and to form distinct ideas either of what is wanted, or of the means by which these objects may be most directly and easily attained; and it is not to be expected that among the university-educated classes, any one should feel that earnest sympathy in the education of the profanum vulgus, which would induce him to give it the long and patient study it requires, to be able not only to shake off the prejudices of his own narrow education, but at the same time to re-educate himself on so broad and liberal a principle, that he shall grasp at once this question in such a manner, as to see clearly not only what is wanted, but how to satisfy these wants.

Notwithstanding these unfavourable circumstances, considerable progress has been made even in this country; partly by the exercise of private liberality, oftener from some accidental circumstance directing public attention strongly towards the attainment of some isolated object, more frequently because we are shamed into it by seeing what has been done by some comparatively insignificant State on the Continent; but most rarely from any well defined object and purpose; yet all these combined have enabled us to get together a very respectable collection of objects of science and of art. They have been found in many respects most useful for their real purposes, and their influence has been beneficially felt on all classes of the community. We have, in short, sketched out the ground plan of the proposed edifice, and collected together a great quantity of materials which will be most useful in the course of erecting it. What is now wanting is a good design for the superstructure, and a skilful architect to superintend the building.

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* I am not going, in these pages, to enter on the question of how much should be conceded to the public or casual inspectors of these institutions, and how much should be reserved for the student. The question is too important to be discussed as a subsidiary one. I may, however, state generally, and at once, that I think that in the British Museum and National Gallery the just medium has been nearly arrived at. A library must always be reserved almost wholly for students. Galleries of art should, as a general rule, be divided almost equally between the two, and the same rule applies, perhaps, to museums of natural history, with perhaps, a greater allowance to the public, as their presence hardly interrupts the studies of the naturalist. On the Continent, the general tendency is, I think, to reserve too much for the student, and to deny free access to the public. In this country the tendency is, perhaps, rather the other way; we are too much inclined to make shows of our museums.

One, perhaps, of the first and most important steps would be the establishment of a Government Board of Education, if not of a Minister of Public Instruction. At present, one branch, that of schools for primary instruction, is delegated to a Committee of the Privy Council. The schools of design, art-unions, and such like, are handed to the Board of Trade. The office of Woods and Forests superintend all the buildings designed for education in every branch. My Lords of the Treasury exercise an undefined control over all the subordinate departments, and the Chancellor of the Exchequer possesses a more than regal veto on every proposal. But, besides this, none of these departments act directly for these purposes, but, in nine cases out of ten, through local boards of unpaid amateur trustees, to whom no responsibility attaches, and who, from their very limited power individually, feel very little interest in the objects they are appointed to promote.

The effect of the establishment of a Government department to direct all these institutions, would be the consolidation of these *disjecta membra* into an intelligible whole, and with a responsible head, who would be answerable to the public for their conduct, who would feel pride in their success, and must bear the blame of their failure. Besides this, there would be a department and office to which suggestions could be addressed, and where their intimate knowledge of the statistics of the question, and their means of commanding information, would give stability and fixity to any plan that might be determined upon, instead of the present hap-hazard mode of doing and undoing, and rushing about, first in one direction, then in another, without knowing what we want, nor how best to attain any object of which we may have an indistinct glimmering.

Besides the Government department, however, I believe that there exists in the capital a body which, if properly used, would be most useful in carrying out the object in view, for in the scientific societies of London there are a great number of learned men earnestly bent on the advancement of the peculiar department of science or art to which they have especially turned their attention. Already the presidents of Royal and Antiquarian Societies and of the Royal Academy are *ex officio* trustees of the British Museum. I would extend the privilege to twenty or thirty other societies, and to some officers of the more important ones, chosen for this purpose. I would amalgamate them with the other trustees of the British Museum and National Gallery; and adding such officers from the University as may be deemed most eligible, I believe a Senate might be formed, whose deliberations would be of the utmost importance to the advancement of the good cause, and which would furnish efficient sub-committees for all the separate departments.

Even, however, before this appointment of a Senate and a Governmental department, we want a distinct scheme, a plan of what is proposed we should carry out; for nothing would be more absurd than to appoint an officer, without at the same time assigning him the task he is to execute. It had better be left to individual energy and local accidents, as at present, than subject our efforts to the interference of a man who must do something to justify his appointment, but does not know exactly what that something should be, nor what the public demand and have appointed him to perform.

I am not going, in the following pages, either to attempt to sketch out such a scheme, nor to suggest the means by which, if such a scheme were hit upon, it should be carried into effect; or, at least, I shall only do this incidentally. What I propose is, to confine my remarks almost wholly to the principal metropolitan institutions, such as the British Museum, the National Gallery, and the National Record Office; as they, I conceive, must first be put on a satisfactory footing before it is proposed to extend the benefit of them to the provinces; and in speaking of them, I do not even propose to examine the general question in all its bearings, but to restrict myself as closely as I can to the architectural question, pointing out what has been done wrong, and suggesting how it may be remedied or better done in future. It may appear absurd, after stating the question in such generality, to descend at once to the criticism of architectural details; but the way I look on the question is analogous to this: supposing it is deemed expedient to irrigate an arid plain, the first thing to ascertain is, would irrigation be useful; the next, whence the water for the purpose is to be brought; and if it is found that some rocks block up the gorge of a valley, and turn a river which would suffice for the purpose into an opposite and useless direction, the first point appears to me to be to show that these rocks do obstruct the flow of the water, and the second to show how they may be removed. When we have got our water, we may think of using it; but it is rather a work of supererogation to plan drains and conduits, and to map out water-courses, till before we obtained a supply of the fluid that is to fill them.

My own belief is, that the architectural question is the rock that now diverts the waters of knowledge from flowing where their fertilizing influences are so much needed, and that the first step must be the removal of this obstruction. Once the water flows fairly through the plain, men will easily find out how to use it. At present, we have tied ourselves up hand and foot by an absurd and most expensive system of architecture. We have thirsted for knowledge, and our architects have given us nothing but stones. To go no further for illustration than the first instance I shall have to adduce, the Government have grudgingly doled out for the purchase of the collections of the British Museum—these collections being, the Museum—345,000*l.* during ninety-three years, and during the last twenty-five have spent more than 700,000*l.* on a building to contain them. If the building were perfect, this perhaps should not be grudged; but as I think I can show it to be about the most inconvenient as well as the most expensive that could well be designed, and that it is that which really prevents the extension of the collection and its being made availably useful, I think I shall be justified in calling it the rock that stops the current for which we thirst. Had, for instance, the conditions been reversed, and 700,000*l.* spent in the collection, 345,000*l.* on the building, we should have been able to look down on the Vatican or the Louvre, and neither the library at Paris, nor that of any Continental city, would have been able to stand an instant's comparison with ours; whereas there are few capitals in Europe which cannot boast of surpassing ours in respect to all its scientific institutions.

In attempting to prove the proposition hinted at in the last paragraph, I shall be obliged to speak loudly in disapproval of the present building of the British Museum. Though I do this, I confess most unwillingly, as nothing exposes an author so much to being misunderstood, as a presumed habit of fault-finding, and it is so easy to answer him, by ascribing to him motives of envy, hatred, and malice, even when he is acting from the purest and most honest convictions. Indeed, so much is this felt in modern literature, that in nine cases out of ten, all criticisms are published anonymously; a mode of writing to which I have a singular aversion; while, as neither in this work nor in any other, have I ever ventured to blame without convincing myself, in the first place, that I know I can do better, and, in the next place, giving the public an opportunity of judging whether I am correct or not in this assumption, I do not think I lay myself fairly open to the objection. But whether this be so or not, it is requisite some one should speak out and take the consequences, which few seem inclined to do, for though I have seldom spoken to any one on the subject who was not louder than myself in condemning the British Museum, whenever I have suggested how advantageous it would be that the public should be put in possession of the objections urged, the answer has invariably been in substance, if not in words, "I know my own interest better!"

The consequence is, that the ignorant gape, the initiated shrug their shoulders; no one speaks out, and wrong is done, and what is worse, persevered in, till it is almost past remedy.

My intention, therefore, is to speak out boldly against what I conceive to be wrong, but one thing I wish especially to guard against before proceeding further, which is that I would not on any account be understood to say one word against Sir Robert Smirke personally. Sir Robert was not an *artist architect;* his friends never claimed that title for him, nor do I know that he ever aspired to it himself. But he was a first class *builder architect*, and in an age when so many failures have taken place, it is no small praise that through straightforward dealing and probity, and thorough knowledge of the constructive principles of his art, no building of his ever shewed flaw or failing, and that he was often called upon to remedy the defects of his brother artists, who did not surpass him in artistic design while they were so infinitely inferior in the constructive department.

In the present instance, however, if Sir Robert, within the compass of his own head, had possessed all the genius of all the architects from Ictinus down to Inigo Jones—or to his own day, if the addition is thought worth much—he could not possibly have succeeded in the task proposed him—for the simple reason that no man ever did, nor, please God, ever will, succeed in telling a successful falsehood. He was told in London, in the nineteenth century, to erect a building to contain a collection of books, antiquities, and objects of natural history, and that this building was to be—or to simulate a temple, built in Greece, to contain an idol or image, in an age anterior to the Christian era!

When Sir Robert was called on, in 1823, to make designs for the new buildings of the British Museum, the Grecian fever was at its height. Men of taste had been so long repeating to themselves the formula, "Architecture is a Greek temple, a Greek temple is architecture," that it was the rankest heresy to doubt the fact, though, for myself, I cannot perceive the smallest connection between the two ideas at the present hour. The temple was an object of architecture, it is true, but in those days idolatry was religion, and an idol, the true object of worship; yet it appears to me singularly bad logic to assert that because it was so then it must be so now; and that we neither may nor can advance beyond what was then done, in either religion or art, the one being then, as it always must be, a reflex of the other. At all events, by a parity of reasoning it would be easy to prove any thing.

Men, however, soon tire of an absurdity, however fashionable it may be for a time—so we have now altered this formula into this form, "Architecture is a gothic church—a gothic church is architecture." Had Sir Robert been ordered to make his designs a few years later, as Mr. Barry was, this would, no doubt, have been the hocus pocus that was to call the spirit of beauty from the vasty deep, where art lies hid from the eyes of modern mortals. The last formula, however, is a decided improvement on the first. Sir Robert was told to perpetrate, not only a chronological, but a topographical falsehood. Mr. Barry was excused the latter, and told only to produce a building which would pretend to belong to the age of Henry the VII., though designed in that of William the IV. It is true, he introduced as light topographical deception, on his own account, inasmuch as he designed his river front on an Italian outline; taking as his model Inigo Jones's Italian design for Whitehall. But he should not be blamed for this, for when men once are forced from the paths of truth, it is impossible ever again to return exactly within their bounds. When the condition of his getting employment was that he should practice a great deception, we should not be surprised at the introduction of a few smaller ones.

It is no discredit to these architects that they have not succeeded, and that we are already tired of their buildings before they are finished, and long for something else; they have performed, as well as any men could do, the task assigned to them, and far better than could reasonably be expected under the circumstances. Whatever blame may be bestowed on Mr. Barry's design, I feel perfectly certain that no architect on the whole Continent of Europe could design anything at all equal to it in any respect. Nor do I know of one in our own country, where we are more "*au fait*" in the style, who could produce anything superior, if indeed anything equal to it.

Nor do I know of anything in the works of the classic architects of the Continent superior to Sir Robert Smirke's. I am certain it is not either the Berlin Museum, nor the Munich Walhalla, or Glyptothek, nor the Paris Madelaine, or Bourse, which, considering the difficulties of the subject, either shew more taste or more knowledge of the style.

The Museum is nevertheless as bad and as extravagant a building as could well be designed; but let the blame rest on the right shoulders. Supposing, when Sir Robert Smirke was called on to furnish the designs, he had told the Trustees that his idea of a library was a range of large rooms, with large windows, so designed as to admit of the greatest number of books being arranged in the most convenient and accessible manner,—that a sculpture gallery was a totally different thing, requiring a treatment dissimilar in every respect, and that a museum of natural history was as different from these two as they were from one another, and that what he would recommend would be three buildings, designed wholly for these uses, ornament being afterwards applied where it was most wanted, and would be most expressive, and the buildings left to group themselves and tell each their own tale, without reference either to Greek temples or gothic cathedrals—The preacher of such doctrines would have been told that he was a mere builder, a prosaic utilitarian, and no architect, and utterly unworthy to design a national monument—the Trustees would certainly have wished him a good morning, and sent for some more compliant person, and he might have retired to obloquy and starvation in a garret, unless his friends had provided him with accommodation in a lunatic asylum. Men, however, will seldom be so quixotic as to attempt this. The proposition of the Trustees was simply this—'do as we wish, and you shall have £35,000 and knighthood—if you insist on your own absurd notions, you shall have nothing' He acted as every man of common sense would do in like circumstances, and if he had any idea he was doing wrong, he kept it wisely to himself.

It is in vain to expect that professional men of any class are to abandon their own interests, and give up their lives to teach the public. If those who have education, and leisure, and the means of carrying out their own ideas, without risk or loss to themselves, are too idle or too prejudiced to think for themselves, it is in vain to expect that those whose bread and whose position in society depend on their pleasing others, will undertake the task of censors and teachers, or that they could succeed if they did. Let the public ask for better things, and point out what they want, and I will answer for the British architects that they will quickly respond to the call. To take one instance: twenty years ago, Mr. Pugin was the only architect in England who could build a respectable Gothic church. The public were pleased with what he did, and demanded correct Gothic churches. There is scarcely now in England a single architect who cannot build as good a Gothic church as Mr. Pugin, and many who can do far better than he can. Let the public ask for buildings designed for their uses, ornamented with taste, and suitable to the climate and age in which they are erected, and it will not be many years before every architect has learned his lesson and is able himself, and has taught others to despise the works of the Greeks and Goths, from the circumstance of his having surpassed them. But if, on the other hand, the public insist on Indian, or Mexican, or Chinese buildings, they may depend on the architects providing *quantum suf.* of that, as of anything else.

It rests with the public, and more especially with the upper classes, to give the direction and create the demand: whatever they ask for will be given them; but on them rests the responsibility of the future as well as of all the failures of the past; and though, therefore, I have much to say against the buildings, I entirely exonerate the architect. As a servant of the public, he did what he was told to do, and did it well. It is true his work is an entire failure; but, I repeat, let the blame of that rest on the shoulders of those who misdirected him in the performance of his duty.

This is a digression, but it is absolutely indispensable for understanding the sequel; for if the Museum is to be either a Greek temple or a cathedral, I have not a single suggestion to offer for its improvement; but if we may acknowledge the presence of the nineteenth century, and admit that we possess the same faculty of common sense that guided all the architects in all other ages, the task before us is simple and easy, and it is almost impossible to mistake the direction in which improvement lies.

BRITISH MUSEUM.

It will not be necessary to say anything further regarding the history of the British Museum in this place than that it was founded in 1753, by the purchase of Sir Hans Sloane's collection for 30,000*l.* The money was raised for the purpose by lottery, which produced, or was expected to produce 300,000*l.* One-tenth of this amount was invested in the funds as an endowment, and still remains there: 30,000*l.* were spent in the purchase and fittings of Montague House, and 10,000*l.* on the Harleian collection of MSS.; but what became of the remaining 200,000*l.*, does not appear in any accounts yet published that I am acquainted with, probably it was appropriated by Parliament as an offset against any votes they might hereafter be called on to make on this account.*

The only circumstance to which it is necessary to call attention here, to enable us to understand the sequel, is the fact, that the Sloanean collection, which formed the basis of the Museum, consisted, besides books and manuscripts, of a collection of coins and antiquities, and also of a large collection of specimens of objects of natural history; so that in its very foundation it consisted of the three great departments that are still found there, and all subsequent acquisitions in each department were naturally added to this collection. But what is even more important than this, is the fact, that down to the year 1833, when the National Gallery was founded, there existed no national institution, either in the capital or elsewhere, supported by imperial funds, to which anything could be sent; everything, therefore, either in the shape of a purchase or donation, went direct to the British Museum, without the least reference either to the propriety of fusing together so many heterogeneous elements, or to the accommodation the institution afforded for their reception; and it is owing to an accident that it did not also become the National Picture Gallery†, as it had become everything else.

This appears to me the radical mistake in the institution, not indeed in its first formation, or in any time during the last century; the collection was then so small that this was of very little consequence. But when the Museum was to be rebuilt, in 1823, the departments ought then to have been separated, and either three distinct buildings erected, on the Museum premises, for the three departments, or, what would have been better, three different localities should have been chosen for them.

The fundamental principle of modern architecture is to cram everything into some Procrustean form determined upon before hand; so the three here were amalgamated into a Greek temple; and although it must now be done at great and needless expense the one mode open to us to repair this great error and put the institution on a satisfactory footing, is to separate the departments, leaving one in the present buildings, and taking the other two elsewhere.

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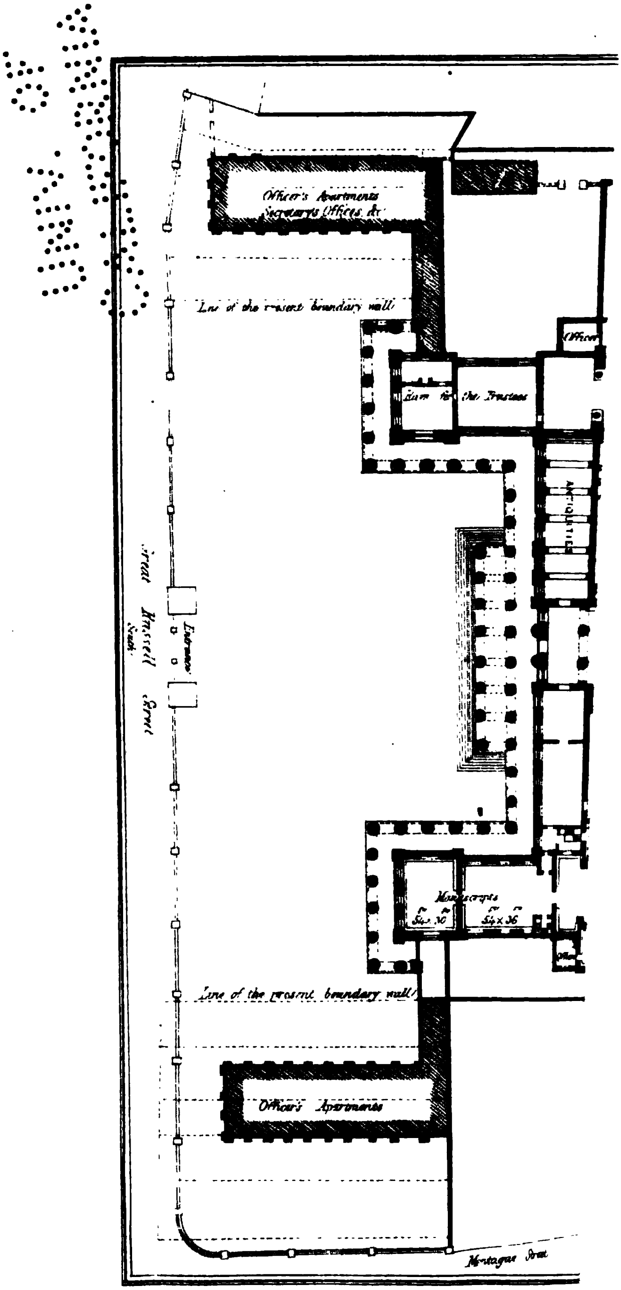
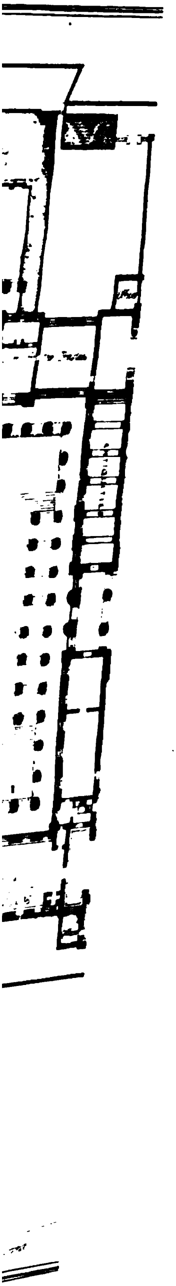
* See Report Brit. Mus. 1835, Appendix 33, p. 568.

† Report of Fine Arts' Commissioners, 1836, Ans. 1383 et seq.


Officer's Apartments
Secretary's Offices &c.
Line of the present boundary wall
Officer
Room for the Trustees
ANTIQUITIES
Great Russell Street
South
Entrance
Manuscripts
54 x 30
54 x 36
Line of the present boundary wall
Officer's Apartments
Montague Street



If this is determined upon, there can be but little doubt hat the library is the one that should remain. The object of he present work is to show how this can be done at the least ossible expense, and so as to prevent any similar mistakes in uture. Before proceeding to do this, however, it will be ecessary to make a somewhat detailed survey of the present uildings, to understand how far they answer the purposes for which they were erected, and are suited for those to which I would apply them.

MUSEUM BUILDINGS—THE LIBRARY.

Referring to the accompanying plan of the British Museum as now built, I shall proceed to make a few remarks on each portion of the structure, pointing out what appear to me its merits or defects, so as to enable my readers not only to judge how far my strictures are justifiable, but at the same time to enable me to point out how far such mistakes should be avoided in future.

The first part of the Museum erected, and the one I shall consequently first notice, was the east wing. When His Majesty George IV. presented his father's library to the institution, it was very properly determined that it should be kept separate from the general collection, and in an apartment designed on an appropriate scale of magnificence. To contain it, therefore, the great eastern gallery was erected, 300 feet long, 40 feet wide, and 30 feet high. Whether or not a room between seven and eight times the length of its breadth was the form best adapted to the purpose, will be presently discussed. The architect had at least the authority of precedent for the form he adopted, almost all libraries being more or less in the form of galleries. The reason for this, however, is generally obvious, for in most instances the book-cases are arranged along the walls, and a long room has, from its form, a greater surface of wall than a more compact one. In this room, for instance, there exists 680 lineal feet of wall, but if the room had been 110 feet each way, though the number of square feet of floor would have been about the same, the wall space would have been only 440 feet.

Another reason in most libraries is, that persons using them, generally go to cases, take down the books they want, and sit down to read them there; and as other parties may be so employed also at the same time, or talking on literary or other subjects, it is a great convenience to students to be able to scatter themselves as far as possible, to be out of reach of hearing any conversation that may be going on, in any other part of the room. These are, I believe, the principal, if not the only reasons for the usual arrangement; but neither apply to a public library; for where students are not allowed to read, the second is inapplicable, and where space sufficient can be obtained, the wall is not the best place for the book-cases, in the first place, because the windows being there also, it is the worst lighted, and the most exposed to damp; so that this reason cannot be used in defence of the present arrangement, while its inconvenience is manifest, from the great distance the librarians and attendants are obliged to traverse to reach the books they want. This is, perhaps, not so much felt in the library itself; but the manuscript department and Grenville library are by this arrangement removed to the distance of more than 300 feet from the reading-rooms, where they are to be consulted; and I need not point out the extreme inconvenience and delay that occur, from every reference or message being transmitted such a distance, besides the great fatigue and inconvenience of carrying heavy books and manuscripts backwards and forwards over such a space.

In the centre compartment of the north wing, for instance, we have a room containing, as nearly as may be, the same number of lineal feet of book-cases, measuring on the floor; but with this advantage, that no book is at a greater distance than 100 feet from the bar of the reading-room, and that to reach the room beyond, the attendants have only to traverse 84 feet instead of 300, which is an advantage not easily over-estimated in such an establishment.

Another point to be considered, in comparing these two rooms, is, that owing to the immense number of lineal feet of wall required for such a room as the king's library, when, especially, one of those walls is reveted with ashlar-work, the one room would cost twice as much to build as the other. If, of course, length and size were the only elements of beauty or magnificence, we ought not to grudge the extra expense to do honour to so magnificent a gift. But I am convinced, that if the proportions of the king's library had been the same as those of the room in the north wing, or rather say 110 feet by 70, or some such proportion, and the 20,000*l.* that might thus have been saved, had been spent in the architectural decorations, by introducing marbles and painting, and a richer style of ornament, a far more beautiful and splendid apartment would have been produced, not to mention its superior convenience.

Alongside of the great room, a range of book-closets has recently been erected, which was avowedly an after-thought, as those who superintended the original design quite forgot what, in an institution of this sort, is really the most important consideration—which is, to provide for any future increase or extension; and they are already forced to eke out their space, by patching and contriving, or by any expedient, however incongruous and inconvenient it may be.

If the king's library is inconvenient from its extreme length, this is much more so, and without any excuse on the score of magnificence and architectural effect, which is not here aimed at, as the whole is more like the cabin of a cargo steam-boat than anything else. But besides this, its incongruity with the room next it—and, indeed, with the whole of the rest of the building —is most painful. In the king's library, for instance, estimating the number of books at 62,000*, each volume has six cubic feet of space allowed it. The dimensions of this room are 300 feet by 18, and its height is 15† feet, while it is calculated to contain 85,000‡ volumes, or allowing less than one cubic foot to each. I admit that the royal books are entitled to more space than the national ones, but twice the space allowed to the one should surely suffice for the other—or three times, at all events. But surely there is a gross incongruity in allowing one, six times as much as the other. Either the national library ought to be better accommodated, or considerable economy might have been exercised in arranging the other.

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* Report of Committee and Brit. Mus. 1835, p. 384.

† I may as well mention that all the dimensions quoted here are taken from the plan published with the report of the Committee in 1838: the dimensions of the floors being generally figured on the plan and reference to scale, there can be no mistake about them, nor as to the height of the principal floor; the height of the closet, however, and of other subordinate apartments are only approximations; but where such is the case, I have always tried to allow an excess.

‡ Report of Committee and Brit. Mus. 1838, p. 11.

In speaking, however, of the library in general terms, it will be convenient to speak of these two rooms as of one; for though they individually present extremes which might be used —unfairly, of course,—in arguing either way, their average is about a fair mean, both as to expense and space; the average of both being, as nearly as possible, three cubic feet of space to each volume, which, as far as I have been able to ascertain, is about what should be allowed. Two feet is admissible in most cases, and four may be granted when extreme magnificence is desired; but one and six are equally absurd and extreme; two and a half to three, is the best average I can arrive at.

Considering the vicious form adopted for the whole library, the reading-rooms are perhaps placed as well as they could be, and as near the centre as possible; but for reading-rooms, they are most inconvenient. The light is so high, and so deficient, in the inner one especially, that in the dark days to which a London climate is so frequently exposed, it is impossible to see to read near the outer wall, the shadow is so deep, from the great height at which the windows are placed. Near the opposite wall, you are too far from the windows; and in the centre, which is the only part tolerably lighted, there is a passage, up and down which people and attendants are continually passing and re-passing, in a manner most annoying to students. They are, in fact, library-rooms, designed as such, and used as reading-rooms, whereas it ought originally to have been determined either to admit the public to the library, or to provide an apartment especially designed for their convenience. Neither has been done.

The centre room in the north wing appears the least exceptionable part of the whole design; and if the wretched pseudo-portico of three-quarter columns had been omitted, and windows twice the size of those "the order" necessitated, or two ranges of windows, been adopted instead, where a magnificent south light could be obtained, it would have been a very perfect room. As it is, it is useful in showing how, even in our climate, and with this defect, a room ninety feet in width can be lighted by side-lights only; and consequently, how extravagant it is to adopt other rooms of forty feet and less, when light can be obtained from both walls.

The rooms beyond this are duplicates of the reading-rooms in dimension: as libraries, nothing can be said against them; but even for that reason alone they cannot be good reading-rooms.

Beyond this, still towards the west, is a room which is an afterthought, not belonging to the original design, and as such fits badly with it, and extends the library to a most inconvenient length in this direction. Had the design of the centre room been continued westward, we should neither have wanted this addition nor the closets to the king's library. It only remains to mention the two rooms on each side of the centre room, facing the court-yard. They are each 50 feet by 22. It would puzzle most people on looking at the plan to find out why, when the rooms next to them, with a north light, are 36 feet wide, they should only be of this dimension. Common sense would seem to dictate that if 36 was admissible with a north light, at least 40 should be used with such a south one as we have here. The mystery is, however, I believe, explained by Sir Robert Smirke himself, as it seems this end of the court was originally to have been graced by a portico, somewhat similar to that towards Russell Street, for once the trustees interfered to save us from this absurdity; and if they had done the same thing by the other, they would have deserved the nation's gratitude. We must, however, be thankful for what they did; but it is much to be regretted that they did not merely insist on the walls of the proposed portico being made solid, but that they did not also see the whole design of this part altered: these rooms have now only 2,200 square feet of floor; they might easily have had 5,600—and where space is so much wanted, it surely was gratuitous to throw it thus away.

These appear to me serious objections to the design of the libraries of the British Museum, and they are such, as by a very little care and forethought, might easily have been avoided. The great and ruling defect, however, is the impossibility of adequate and convenient extensions; the inconvenience of the makeshifts already adopted is generally felt, and cannot much longer be concealed or tolerated. They have been slurred over hitherto; but before long the Gordian knot must be cut, and the whole re-organized in some way or other. To this, however, I shall return presently, and meanwhile will pass on to the sculpture galleries, occupying the west wing of the building.

SCULPTURE GALLERIES.

The first room we meet with in our survey in this direction is the great Egyptian saloon. Like the centre one in the north wing, it appears to me a very appropriate room for the purposes for which it is designed; its dimensions are colossal, so are the sculptures placed in it. The light is sufficient, and sufficiently diffused, and for Egyptian sculpture it is of very little consequence how or in what direction the light falls. The artists on the banks of the Nile never aimed at Œsthetic beauty of form, so that the sculptural products of their art scarcely depend more on their shadows than architectural members do. It would of course have been preferable if the light had been steady on the colossal busts, and not on their backs in the morning, and their faces in the evening, and there are various defects both of style and detail, that I cannot help wishing were otherwise: but let this pass. If the rest of the Museum were as well and as appropriately designed as this, I would not say one word against it.

In the central saloon we again fall in with our three-quarter columns, and consequently have a most inefficient light from the only wall through which it could be introduced, and the room is dependent entirely on the borrowed light it receives from the three galleries which abut on it, which renders it totally unfit for the exhibition of either Egyptian or any other sculpture; it is, indeed, so much space thrown away; but where there is so much waste, we may easily pass over this.

The Phygalian room is, or was, only meant to receive the frieze of the Temple of Apollo Epicurius, and for such it is by no means badly designed, except that if it had been only half the height it is, it would have been a more pleasing apartment, better suited for its purposes, a better vestibule to the Elgin room, and more than this, a more than sufficient light could have been admitted over its roof to the central saloon, and indeed this could now be done at a very small expense.

The Elgin room, however, does not deserve even this qualified praise. Even as an architectural object, without reference to its purposes, its proportions are bad, being four times as long as it is broad (143 × 37). The Parthenon would have furnished a better model, or as 100 to 225: but even this is long for an interior, which, without great management and occasional breaks, is almost never pleasing when the length is an excess of twice the breadth: in this instance, also, the great height of unbroken wall makes it look narrower than it should do. As for its architectural decoration, it has none worthy of the name; and it is difficult to understand why antæ and panelling should have been lavished as they have been on the Egyptian saloon, where the character of the antiquities did not require it, and entirely omitted among sculptures, which were designed and executed expressly to form integral parts of an architectural decoration. No sculptures in the whole world require architectural assistance so much as these. May I say, *therefore*, they are accommodated with the plainest walls in the whole edifice?

The real defect, however, is, that it is unfit for the satisfactory lighting and exhibition of the sculptures it was built to contain. When the principal group was situated in the centre of the room—which it was till a year or two ago—the light was perpendicular on the heads of the statues, about as unfavourable a light as they could be placed in; and even now, that they are removed a little on one side, it is far too high, and from the narrowness of the room, they can only be seen at such a distance as to enable the spectator to judge correctly of their effect, by standing in the Phygalian room and looking through the doorway. The other groups are as badly lighted, and I quite agree with what the late Mr. Rennie told the committee in his evidence*, that no one knows or can know what the Elgin marbles are in their present position, and that the only mode available is by getting casts and lighting them properly. As antiquities, their value will always be the same, however they may be lighted; but I am convinced that I do not exaggerate when I state that the value of any such as have pretensions to artistic merit, would be doubled if they were placed in a light where they could be seen to advantage.

The frieze is tolerably lighted, and there would be no objection to its position, except that since it has been found necessary to push the larger groups against the wall—the frieze cannot be seen through them, nor is there space sufficient between the wall and the groups to enable it to be seen to advantage. I speak moderately when I say the metopes are destroyed when built into such an expanse of flat red wall—in the same manner in which the Turks used the Bodroun marbles—they are insignificant and inharmonious to such an extent that they would convey a very mean idea indeed of the age of Pericles, if we did not allow for their position in estimating their merit.

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* See Report of Committee of 1836, Ans. 1208, et seq.

Except Mr. Westmacott, I never heard of a sculptor who had one word to say in favor of this room, and I am certain that there is no one who, if he had an opportunity of seeing these noble works of art in a proper light, would not cry out against the profanation of their being placed where they now are.

In the present instance this is the more to be regretted, as the remedy was easy and obvious; for had the gallery, even in its present form, been only built at right angles to its present position, and with one end abutting on the central saloon—the entrance consequently being there—and had the light been introduced either at the top of the north wall, or, what would have been better, from a cove, it would have been as perfectly lighted as a gallery can be by day-light, and all this without one sixpence of extra expense or any loss of architectural effect; indeed, by a slight alteration of proportion and arrangement, a much more pleasing architectural object might have been attained. This, however, is not possible now; but it was a gross and unpardonable blunder to run it north and south, and so spoil it, when it might as easily have run east and west, and so been made a very tolerable gallery for the purposes for which it was designed, besides occupying far less of the available space than it now does.

If, however, the Elgin gallery is bad, what shall we say of the Townley gallery, "horresco referens!" now in course of erection. I would willingly stake my reputation as a judge of such matters, or anything else, on the assertion, that when it is complete, it will be found to be the worst gallery for the exhibition of æsthetic sculpture that exists in any city of Europe.

It never is easy to build a good sculpture gallery. Comparatively, it is easy—is a trifle indeed—to build a good picture gallery, though we know that even this is not always successfully accomplished. A sculptor, unfortunately for him and his art, depends solely on the light in which his work is placed, for the effect which it may produce. A painter, on the other hand, puts in his lights and shadows before the work leaves his easel, and they never afterwards can be altered or put out. If he paints with water, or in tempera, or any material which is not glossy, it is little matter whether the light that falls on his picture comes from above or from below, or from one side or the other; it only requires to be sufficient, and his work has all the effect he designed or put into it. If he paints in oils, all that is required is, that the light shall not fall on it in such a direction as to be reflected from the glossy surface to the eye. The direction in which it comes is immaterial.

With sculpture, however, this is not so, as any one may convince himself who will place a light on his forehead, as miners do—it should be between the eyes—and with this will look at a clean cast of a bas-relief and a white slab of flat plaster placed side by side, he will not know on which the sculpture is; or if he looks at a statue with the same light, it will look as if cut out of pasteboard. Place the light on the ground so as to throw the shadows upwards, and the best piece of antique sculpture will become absolutely ludicrous; introduce it either from one side or the other horizontally, and the figure becomes lopsided and disproportioned, to an extent which would be incredible to those who have not tried the experiment.

To see a statue in perfection, the light should be introduced from only one point, and that point should always be above the statue: as a general rule, it should fall at an angle of about 45 degrees, varying of course with the nature of the work, and the nature and extent of its under cuttings. It is difficult to obtain this in galleries of any extent; so that generally statues are better seen by artificial light than by day. The Romans seem to have perceived this, and kept their best works where only artificial light was introduced; and to this day the greatest treat that awaits the traveller in Italy, is to see the Vatican by torch-light. Artificial lights would scarcely be tolerated in the British Museum; but there might always have been the steady north light of day, and at the required angle. Instead of this, we are to have a number of scattered lights, some facing the east, some the west, so that in the morning one-half of the statues will have a strong light in their faces, the other half having their "rear fronts" brilliantly illuminated: in the evening the case will be reversed, and during about two hours of mid-day, or when the atmosphere is so cloudy that nothing can be seen properly, the statues will have sixteen lights shining upon them instead of one; and the strongest—because the nearest—being that immediately behind them, and consequently the one that interferes most with the spectator's vision, and falls in the most unfavourable position on the statue.

It is difficult to estimate exactly the amount of destruction that will be thus effected; but I have no hesitation in asserting, that if a statue depending so purely on æsthetic effect as the Venus di Medici, was worth 5000*l.* in the tribune at Florence, it would not be worth 1,000*l.* in our Townley gallery. The collection as it is, will probably be destroyed to the extent of almost one-half.

This, however, is not the only defect. A colossal room is suited, as I said before, to the colossal sculpture of the Egyptians; but a piece of Roman sculpture, about the natural size, placed against a wall 30 feet high, becomes the statue of a pigmy, and if the room be 41 feet wide, and some 2 or 300 long, the collection loses entirely its importance, either as a whole or as an assemblage of individuals.

As nearly as I can estimate, no statue ought to be placed against an unbroken wall more than three times its own height, or it will lose symmetry and effect, and even then it requires panelling and architectural adjuncts to prevent its being dwarfed. Additional height may easily be given to the room by cornices, or coved, or vaulted ceilings, taking care only that the masses shall not be so great as to make the statues which are meant to be the principal objects look small and insignificant.

It may be asked, if this gallery is so manifestly bad and absurd, how came any man in his senses to design it, and any board of trustees to tolerate such a design? The explanation of the anomaly is unfortunately easy. When Sir Robert Smirke made the design, the Grecian fever was at its height, and among other dogmas inherent in this absurdity, was the idea that perfect symmetrical regularity was a necessary and fundamental principle of this style. Never was doctrine so false or slanderous; but so it stood then: so Sir Robert believed, and, consequently, *because* the royal library was built after one design, *therefore*, the sculpture gallery must be built exactly like it! If there are two classes of buildings in the whole world requiring treatment more essentially differing from one another, it is these two; yet to satisfy the requirements of this empirically assumed absurdity, the gallery was erected to match the library, and the statues are doomed to be caricatured, as they will be.

Twenty-five years ago this might have been excused; but after having a quarter of a century to reflect on the subject—after having seen all that has been done on the continent, and having all the means of information and observation we now possess, to set to work in the year 1848 to erect such a building, is a piece of gratuitous wickedness I scarcely know how to characterize.

I would not insult sculptors by asking them if they could work, or even permit their works, to be exposed in such a gallery as this; but if the trustees would even ask the plaster casters in the New Road, if they would accept of such a one for a warehouse, I am very much mistaken if most of them would not decline to spoil their wares by exhibiting them in such a place.

The Lycian room is the only one of the sculpture galleries, which is placed in the right direction, and where, consequently, a proper light might have been attained. Unfortunately, however, it has been spoiled by the introduction of a cross-light from the south also; but this might be remedied even now, by building or blocking it out. Were this done now, however, the light, perhaps, would not be quite sufficient: but even in that case the single north light would display the finer pieces of sculpture to far more advantage than could be done in any other room in the Museum. It has, however, most unfortunately been appropriated to a class of sculptures whose æsthetic merit is not great, and which consequently does not depend on a fine single light for being understood. As far, however, as it is possible, they have been destroyed, by the mode in which they are lighted. The principal ornament, for instance, on the great tomb is the bas-relief on its curvilinear roof, which, from this cause, is so indistinctly seen, that few are aware of the existence of any sculpture on this part of the monument; and no man can say he has really seen it since it was in the Museum. The whole room, however, is too small for works of this class, so that even if properly lighted, they should never have been placed here.

The Sala alla croce Greca, which comes next in our survey, is scarcely lighted at all; and, judging from the gloom of the corresponding apartment in the east wing, (which, however, is better lighted than this one can be,) will consequently be most unfit for the exhibition of any thing requiring either a strong or good light: it has, however, the merit, which the Townley gallery has not, that its lights do not cross one another, and the eastern arm being lighted by one window from the north, will, perhaps, be the best position for a statue in the whole Museum; and next to this the southern arm, which also has only one window, though that being a western one, will neither give so pure nor so steady a light as the other. Neither of these lights, it is true, are sufficient; but with statuary, a rush-light in the right direction is preferable to a torch in a wrong one.

Next to this room to the eastward, we have an apartment 75 feet by 32, where, at last, we have a noble north light,—the one place, except the Lycian room, where sculpture could be seen to advantage, and which would have formed a noble pendant to that gallery, and the vista produced by this opening on entering the Museum, or standing at its intersection with the Townley gallery, would have been superior to any architectural effect the building now possesses. Will any one believe it?—this room has been appropriated to the staircase!—its windows built up, and the light introduced from the roof. Instead of this we have a south room, which, though only 22 feet in width, is so completely darkened by the pillars of the portico, that the sculptures, even when placed on the wall opposite the windows, can be only very imperfectly seen, and the floor and opposite wall are absolutely useless. Why was not the staircase placed here? and with its lights blocked up, which they then would have been, ten feet might have been added to the depth of the

Museum without any inconvenience, and the one north light in the body of the building spared to us for the purposes for which it was wanted. Or why was not the staircase projected into the courtyard, in front of the entrance? Its effect as an architectural object would then have been finer, and both these rooms remained to the Museum.

Of the gratuitous blunders made in arranging the parts of the Museum, none appear to be more glaring than this. The expense would have been exactly the same whether the staircase had been put on the south side of the intermediate wall, or if placed on the north, as it now is; while the gain both in space and light, as well as architectural effect, by the arrangement not adopted, would have been greater than can well be understood by those who have not specially studied the subject. The other arrangement suggested would, however, I believe, have been better than even this.

NATURAL HISTORY DEPARTMENT.

It is scarcely necessary to make any remarks on the rooms in the upper floor of the Museum, as they necessarily followed the plan of those below them. This no ingenuity could avoid; and the only mistake was the great one, inherent in all the arrangements of the Museum, of grouping together such incongruous departments in the same building; but as it was ordered to be done, and at the same time determined that the zoological department was to take its chance of accommodation where it could find it, we should not be surprised at a few inconveniences and inconsistencies in the mode in which it is arranged. It was a piece of gratuitous mischief to make the sculpture gallery like the library, when there was no connexion between the two; but it could not be helped that the ornithological museum should be like the King's library, when it was placed over it.

This gallery, we learn from Sir Robert Smirke's evidence*, was originally designed to contain the national collection of pictures: where the birds were to have been accommodated, had this intention been carried out, does not appear. But, luckily, Wilkins' suggestion for building a gallery in Trafalgar

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* Report of Committee, 1836, Ans. 5281, et seq.

Square saved us from having another department crowded into this already overstocked building, and was the first step in the right path, which, unfortunately, has not been followed up further.

How ill fitted it is for a picture gallery, from the lowness and form of its roof, is easily to be seen by any one who will try and discover what the pictures are that now adorn its walls. The information afforded by the "Synopsis"* is singularly meagre; but it is all that can be obtained on the subject. Bad as our present gallery is, this one would, no doubt, have been worse; but we are saved this, and it is no use looking back now to the dangers we have actually escaped.

The defect of these galleries for the exhibition of specimens of natural history does not lie either in the form of the rooms nor the mode in which they are lighted, but in their general plan, which renders it impossible to arrange the kingdoms and classes in anything like natural order. To the scientific man, who knows to what class and genus every specimen belongs, this is of no consequence; the order in his brain is so perfect, that no disorder among the specimens can puzzle or perplex him. But as the Museum is also designed for the instruction and amusement of the unscientific classes, it is almost absolutely indispensable that the genera should be arranged according to their affinities, and the kingdoms at least be arranged according to some well understood mode of classification.

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* Having so many other subjects to write about, it was not my intention to mention the Synopsis; but as the committee of 1835-6 took such pains to improve it, I must mention one fact to show how much really useful information it contains. When in the East, I had many opportunities—more than was always pleasant—of observing the snakes of Bengal, and was often puzzled to know which were poisonous or hurtful, and which were harmless, as the natives were never quite sure, and always exaggerated on the side of accusation, while actual experiment was neither easy, nor always agreeable: consequently, when I returned to this country, some ten years ago, seeing a section in the Synopsis, headed in large capitals, "Harmless Snakes," I immediately proceeded to see if some of my much maligned friends were not entitled to that honourable appellation. The principal ones mentioned in print, or exhibited in the cases, were the cobra de capella, the whip snake, the boa constrictor, and others allied to them. Having all my life believed them to be always the most hurtful of the race, I thought it must be a misprint; but as the Synopsis has since this time gone through several editions, and as the copy I bought at the Museum, last week, contains the same assertion in capital letters, I can only confess how ignorant I am of Erpetology, and am only pleased that I am not alone in my ignorance, which is universal on this head, in the benighted regions of the East. But this being so, would it not be worth while in the trustees, and worthy of this great nation, to send out one of their curators, perhaps Mr. Gray, himself, to enlighten our fellow-subjects on this head? I can solemnly aver that I have known men die from the kiss of the cobra, and known them give up the ghost under the fraternal embrace of the boa—from fright, I suppose—in utter ignorance of the kindly nature of the animals; while here they have been existing, for Heaven knows how many years, in the British Museum, and bit and killed nobody! Truly these great national establishments are of wonderful importance for the accumulation of correct scientific information, and the correction of vulgar errors; but they have also another, perhaps a higher mission, which is its practical diffusion among our fellow-men. Can any material fact be more important to the well-being of our fellow-citizens in the East than this?

As it is, as you enter at the head of the stair, you find the mammalia—beyond them the birds. The molluscous shells are arranged, it is true, with the birds' eggs, in the same gallery; but this is unimportant, as the space might otherwise be thrown away, and the distinction between the classes is so great that no mistake can arise. But after the birds comes a collection of skulls, and beyond this a narrow gallery containing a collection of mammalia, amphibia, reptiles, fishes, insects, and Heaven knows what, in most admired confusion; and certainly it would puzzle most people to find out why the hares and rats should be so far separated from the other mammalia, or what affinity they have with the crocodiles on the tops of their cases, and the corals in front of them, or with the fish and serpents between which they are placed. The truth of the matter appears to be, that in consequence of the fortunate removal of the National Gallery the birds and shells have inherited an apartment in which they could be properly arranged; but no other class being equally fortunate, they have been arranged anywhere and anyhow. But is this as it should be?

COURT-YARD AND PORTICO.

It remains only, before leaving this part of my subject, to say a few words regarding the court-yard and the portico, which, however, are the fundamental sins of the whole design, and the causes of at least the greater part of its other defects.

Taking the court-yard first, its dimensions figured on the plan are 238 + 317; it consequently occupies more than 75,000 square feet of ground, which ought not to be thrown away in London without some good cause or some great object to be gained, what these are, in this instance, no one has hinted, so far at least as I am aware, nor can I suggest. Is it supposed to be beautiful? I think it cold, and lean, and wretched, as all courts are, more or less, in our climate, and especially a pure Greek court, as this pretends to be.

This, however, is a matter of taste, regarding which I will not dispute; but supposing it beautiful, how much is its beauty worth? I feel convinced I understate the matter when I say it has cost 100,000*l.* Is it worth this? Of course I do not mean to assert that the actual ashlaring and the three-quarter columns and antæ cost this sum; but the whole Museum has been sacrificed to it. It is to obtain this court that the building is spread out as it is, that the south light of the north wing, and the north light of the south wing are thrown away; it was to obtain its frigid regularity that the sculpture galleries were made duplicates of the library, and generally, that so few and such inconvenient lights were obtained throughout the building. Altogether, considering the space sacrificed, the actual expense incurred directly and indirectly, the advantages thrown away for this court, I believe I am nearer the truth in estimating the expense of the court at 200,000*l.* than at 100,000*l.*

Perhaps it may be of some use? There are two doors in the north wing, and it may be a convenience that visitors to the Museum may pass through the court at once to the stairs at the north-west and the reading-rooms at the north-east corner of the building. If any one, however, will take a pair of compasses and measure it, he will find that on entering the front door, he will have to pass over the same number of lineal feet of space, neither one more nor one less, if he proceeds to those points by the sculpture galleries and King's library, or if he proceeds along the alleys of the court. I would therefore ask, out of one hundred men, how many, after once entering the building, would of their own free choice again go into the open air in proceeding to their destination, or would rather prefer, either in winter or summer, not to mention in rain, to remain in the house they have entered? I will venture to assert that not one in a hundred would go voluntarily into the court for that purpose; and I would recommend the hundredth man to take a turn in the court in front of the Museum instead; it would answer his purpose as well, and remove this hundredth part of a reason for the absurdity.

The plan shows it is not necessary; and even supposing it beautiful, who is to see its beauties? It cannot be seen from the outside. There is not one single window in the whole building from which it can be seen, and the only place where visitors can get a peep at it, is through the panel of a door which the trustees have ordered to be glazed for this purpose. Supposing, however, they had allowed this door to remain like all other doors of that size in the three kingdoms. If they had kept their own secret, and the door shut, no one would have found out, for the next fifty years, whether the court-yard existed at all, or if it existed, whether it was of stone or brick, or what its shape and decorations consisted of. A resolution of the Board of Trustees to this effect would have saved the nation all the money, and no one would have been the wiser, or have known whether it existed or not, and certainly no one would have been a loser.

At all events, had the Trustees or their employées possessed the smallest idea of consistency, they would have spent a few pounds in reveting with stone the external returns of the building immediately behind the front portico, which no one can pass the building without seeing, when they were lavishing so much on what no one can see, or need be aware of. These returns now tell a tale of mixed magnificence and meanness, far more offensive than if the building had no pretence to ornament at all, and reveal the whole to be but the mockery and the sham which it unfortunately is.

The last feature to be mentioned is the portico. For this the only excuse is its beauty: if it is not beautiful, it is most inexcusable: if it is beautiful, a strong case is made out in its favor. Whatever its other defects may be, it certainly does not possess what is the strongest objection to the court, which is, that it is not seen; for no one can either approach or pass the Museum without its catching the eye; it is, therefore, in the right place, which the other is not; and if ornament was to be added to the Museum, it is here that it should be placed. Is it then beautiful? This is a matter of taste, which each must answer for himself. At the time it was designed, I can perfectly understand that the Trustees thought it beautiful, and perhaps nine-tenths of the university-educated classes would then have thought so also. Since, however, it has been erected I have not heard one voice raised in its praise, and certainly not one word of laudation has been printed that I am aware of*; but, on the contrary, blame has been both loud and deep.

For myself, I can only say, that I think the design both cold and unartistic, and for this climate, singularly incongruous and inconvenient. Its lowness is an inherent defect of the style adopted: but instead of the gay, cheerful architecture of the Greeks, there is a dismal funereal look about this specimen which, to my mind, is singularly repulsive. I trust I can admire and appreciate Grecian architecture as well as most of my neighbours; but had my advice been asked, I would have recommended to Parliament, when they had made up their minds to spend a large sum of money in producing a columnar specimen of it, to take the forty-four columns, and with them to have erected a regular peristylar temple in one of the parks, or in some ornate part of the capital. Their number is exactly sufficient for a regular octastyle temple, larger than the Parthenon. It might have had a regular cella, and they might have placed in this an image of Venus, or Plautus, or Pluto, or any god or goddess they desired to do honour to, and it might thus have been a more perfect specimen of that style than the much-lauded Madelaine.

What I object to is, that instead of this they ordered these columns to be stuck up in front of a museum, in the dingy district of Bloomsbury, for no other purpose apparently than to darken its windows, and make its internal arrangements as inconvenient as could be; and they have thus furnished that unfortunate institution with a straight-waistcoat and a barred prison, which now prevent it moving hand or foot, and have already fairly checked it in its career of usefulness and advancement; though it is yet too soon to feel all the inconveniences of this fatal policy.

Another reason for adopting the plan I am recommending would have been, that the temple would not have cost

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* Since the above was written Mr. Ruskin's testimony has been given in its favour in his "Seven Lamps of Architecture." Of what value his opinion may be, I leave to others to decide.

100,000*l.**, whereas the attempt at making the Museum look like a temple, has entailed an expense to more than twice that amount; thus weighing down the institution with a load of useless expenditure, at the same time when they were steadily refusing such sums as 1000*l.*, 2000*l.*, or 3000*l.* for objects of the most vital importance for the real objects for which the Museum was founded.

EXPENSE.

To enable us to understand many of the assertions in the preceding pages, and almost all that follow, it will now be necessary to analyse more particularly the expenditure of the British Museum since its foundation. Fortunately we are able to do this with a considerable degree of accuracy, from a return obtained by Mr. Hume, ordered to be printed by the House of Commons, 2nd June, 1847, and another presented by the Office of Works, &c., 2nd March of the same year: from these we learn that from the year 1753 to 1846 there was expended—

On salaries, wages, and appointments		404,202*l.*	
On house expenses		34,433	
On rates and taxes		30,096	
On miscellaneous expenses		195,170	
			663,901*l.*
COLLECTIONS.			
Sir Hans Sloane's collection		20,000	
On manuscripts		40,850	
Printed books, maps, music, &c.		92,447	
		153,297	
Antiquities, coins, medals	122,115*l.*		
Prints and drawings	28,109		
		150,224	
Natural history generally	10,405		
Minerals and fossils	17,238		
Zoology	12,751		
Botany	1,204		
		41,598	
			345,119

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* I will not now stop to inquire minutely how much the portico actually cost in constructing, but will assume 1000*l.* for each pillar as an approximation, or 44,000*l.* for the whole: it may or may not have cost this sum directly, though indirectly it

BUILDINGS.

Old buildings, repairs, and fittings .		108,194*l.*	
Purchase of land and leases for new buildings		43,966	
New buildings from commencement in 1823, to Christmas, 1846 . . .	606,500*l.*		
Estimate for completing the same in the years 1847–48, and fittings . .	106,911		
		713,411	
			865,571
Total expenditure			1,874,591*l.*

On the first group of figures I have no remark to make; the first three items are absolutely requisite; the fourth might afford interesting materials for dissection, were the particulars given; but as there is no return to show how or for what purposes the 195,000*l.* were spent, I must pass it for the present, merely mentioning that it seems to include the 10,000*l.* for publishing the Alexandrian Manuscript of the Bible, 16,000*l.* for publishing the Museum Antiquities, some 20,000*l.* to 25,000*l.* for the Catalogue of Books, and such-like items, of which no details are given.

The principal point to which I would especially wish to direct attention in the above table is, that only 345,000*l.* have been grudgingly granted for the collection, while 865,000*l.* have been most lavishly spent on the buildings destined to contain it—the difference being more than half a million of money in favour of the buildings. Supposing these conditions reversed—and I shall presently show they might have been so without inconvenience—and the larger sum spent on the collection, the smaller on the buildings; we might have had such a collection as should have left us nothing for which we should have to envy Rome its Vatican, or Paris its Louvre and Royal Library. Indeed, our collection would then have been superior to that contained in all the different collections of any city on the continent: as it is,

has cost the nation more than twice that sum. If this is objected to as too much, I shall be happy to reduce it, as hereafter I propose using it on the opposite side of the question, and every diminution will tell in favour of my argument.

we are still inferior to even such a second-class place as Munich, and cannot see our way to rival either Rome, Paris, Vienna, or indeed any first-class city.

Had the enormously disproportionate expenditure been incurred in the far-sighted policy of erecting a class of buildings which should be capable of containing not only the present collection, but the probable additions during the next century, it would in the long-run have proved a wise economy, which no one could blame: but what is the true state of the case? When the present collection is moved into it, the Museum is not only filled, but crowded, and extension impossible. Already the library has been patched and eked out by every conceivable contrivance, and will not now contain the present collection. The Natural History department cannot be extended. The Trustees have been forced to refuse a collection, so much wanted, of national antiquities, because they have no room. They are by no means anxious that the rest of Mr. Layard's collection should come home, or his excavations be extended, because they do not know what to do with what they have got already. No Indian department can be added, from this cause; and, in short, though the public are thirsting for knowledge, and unlimited wealth is offered to us on all hands, we are chained, Tantalus like, to the pillars of our Museum, and cannot slake our thirst from the waters we see everywhere around us.

Had the Government been able to take an enlarged view of the matter at the time the Museum was founded, the whole of the 108,000*l.* spent on the old buildings might now have been available. There is scarcely a capital in Europe (Paris and Rome for instance) where the bulk of the museum buildings are not more than a hundred years old, and they probably will serve for a much longer period yet. But in consequence of the vicious system of providing only temporary expedients, which prevails in these matters in this country, the whole of this money is literally thrown away, though a considerable portion of it was spent within the present century, all of which at least might have formed part of a great scheme; but nothing of the kind was ever dreamt of; and literally not one brick of these buildings now remains upon another; and so far from learning a lesson from this experience, we are now repeating the same mistake, only on a more extensive and more expensive scale.

The next item is 43,966*l.* for the purchase of land, which was wanted wholly and solely for the officers' residences, which form the two wings of the buildings: to this sum, therefore, we have to add 36,000*l.** which they were estimated to cost; so, that supposing them to have been built for about this sum, we have an expenditure of 80,000*l.* for seven dwelling-houses, or nearly 11,500*l.* for each; or in other words, taking the money at 5 per cent., at a rent of 500*l.* to 550*l.* for small second-class unfurnished dwelling-houses, which appears large, when it is considered that dwellings as convenient and as conveniently situated, might have been obtained to any extent, to purchase at from 2000*l.* to 3000*l.*, or to rent at prices ranging from 100*l.* to 200*l.* per annum. This, however, is one of those items on which Government never grudge money. The Trustees have only to ask and it is given; but to me it is provoking to see 80,000*l.* thrown away for such a purpose, when I know that a tithe of that sum would have secured the Egina marbles, now the principal ornament of the Munich Glyptothek, and less than a tithe of it would have excavated to its base the great Mound of Nimroud, and landed its treasures safely on our shores. For such purposes as these, however, the Treasury have not a sixpence to spare—for building dwelling-houses, the public purse is inexhaustible.

There now remains to be examined only the large sum of 713,412*l.*, spent on the new buildings: of this 106,911*l.* is an estimate to be expended in 1847-48. Whether it was meant to suffice for finishing the remaining buildings or not, is not quite clear; certain it is that a very great deal of work remains to be done in 1849; but it may be that when the estimate was made, it was thought that the whole might have been completed last year, and as I am anxious to guard against overstating the expense, I will assume that this is the case, and also that the work can be done for the sum estimated for; though this has not been the case hitherto in the building.

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* See Sir Robert Smirke's Evidence before the Committee of 1838.

In the same evidence it is hinted, as an excuse for building these residences, that the officers would thus be enabled to take to their homes such parts of the collections as they wished to examine more leisurely, which they could not do if their dwellings opened on the street, or indeed had any communication with the outer world except by the one great entrance to the Museum. In plain English, it required the porter to keep the officers from stealing the collection entrusted to their care—a slander as absurd as it is uncalled for, and the remedy as absurd as the slander; for it is not likely the porter will question any officer who goes out or in with anything in his hand, or under his arm, or indeed who orders anything to pass. Surely the officer is a better judge of what should go in and out, and more to be trusted with this discretion than even the very respectable individual who now acts as portcullis to the institution.

To arrive, however, at the actual cost of the building itself, it is necessary to deduct the above-mentioned sum of 36,000*l.* for the dwellings, and also a sum for the fittings, for which we have no exact data. As, however, Sir Robert Smirke guardedly states that the estimates include finishing the rooms in every respect for the reception of the cases, and as a great part of the antiquity department requires scarcely any fittings at all, I feel convinced I am allowing a sufficient sum when I put down 77,412*l.* for fittings and furniture, which leaves 600,000*l.* for the actual cost of the building itself*.

The next point we must try to ascertain, is the relative expense of each department or portion of the Museum. This, however, would not be easy, even for the architect himself, and can only be done approximatively at best. If, for instance, it were ascertained that the east wing cost 100,000*l.*, what portion of this should be ascribed to the books, and how much to the natural history department? If we take the cubic contents, the one being thirty feet high, the other twenty, they would be in the ratio of three to two. But this is manifestly unfair, as the floors, roofs, foundations, &c., which really are the bulk of the expense, are the same, whether the walls are a few feet higher or lower; and altogether, it is almost impossible to be perfectly exact, when one department is placed over the other. I have, however, taken considerable pains with the subject, and believe the following table to be a very near approximation to the truth.

Taking the floor room† of each apartment of the Museum, I find that the whole area, exclusive of the portico, is 166,500 square feet; which are apportioned as follows:—

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* Report of Committee, 1838, Ans. 70 et seq. From the answers to the Committee of 1836, it would appear (see Ans. 5345) that a portion of the fittings were sometimes included in the estimates, but it is safer to take it as I have stated.

† I have taken the floor room instead of the whole area, including the walls, because the dimensions of the rooms are figured on the plans published by the Parliamentary Committee; whereas the general dimensions are not, and it is not safe to trust to scales and compasses in plans drawn to so small a scale as these are.

To antiquities, including print and coin rooms		52,000 feet.
Natural history		46,000 „
Printed books	40,000	
Manuscripts	12,000	
		52,000 „
Entrance hall, stairs, offices, rooms, &c.		16,500 „
		166,500

If, therefore, we deduct from the above sum of 600,000*l.* the sum of 44,000*l.* for the portico—I hope it is enough—there will remain 556,000*l.*, which, divided by 166,500, gives an average of about 3*l.* 7*s.* for the expense of each superficial foot of available space. It would not of course be fair to apply this indiscriminately to all the departments; but the following is probably very near the truth.

Entrance hall, stairs, &c., at 4*l.* = 66,000*l.*, to be apportioned to the other departments.

MSS. at	3*l.*	10*s.*	= 42,000	+ 5,280	= 47,280*l.*
Books	3	10	= 140,000	+ 17,600	= 157,600
N. Hist.	3	0	= 138,000	+ 20,240	= 158,240
Antiquities	3	5	= 170,000	+ 22,880	= 192,880
			490,000	66,000	556,000*l.*

It results from these calculations that, if we assume the appartments allotted to printed books to contain, or to be capable of containing 500,000 volumes, the cubic space allotted to each volume is considerably under two feet and a half for each, and at the same time that the expense incurred for lodging each is 6*s.* 4*d.* per volume; and if we apportion its share of the portico to this department, it would add more than five pence to the expense of lodging each volume.

It is not of course possible to estimate the expense of lodging each individual article in the same way, in the other departments—they are so various in size and in the space they require; but we shall be able to judge whether the work has been done economically or not, by a reference to the above tables, when we have adduced instances of what the expenses might have been if another mode of building had been adopted.

IMPROVED FORM PROPOSED.

These statistics are no doubt interesting; but the question that will occur to every one is, Could the collection be equally well accommodated for a less sum? My answer is, that it could have been better done for less than one-sixth of what has been spent on the present building.

The most obvious and direct way of proving this would be to make a design for such a building as I would propose, to make out a bill of quantities, and affix prices to them, and thus show the comparative cost of the two buildings. Such a mode, however, of going to work would involve immense labour in making the drawings, great expense in engraving them, and great difficulty in obtaining correct estimates, as we all know how difficult it is to obtain any that can be depended on, even in the simplest cases. I shall not therefore attempt this, especially as another mode is open to me, which is less liable to cavil, and will probably be deemed as satisfactory. It consists in taking a building which has been erected, and whose cost is consequently known, and which would answer nearly for the purposes we are proposing, so that with a few obvious alterations it may be adapted to its new destination. Such a building we fortunately have in the great flax-mill erected by the Messrs. Marshall at Leeds, a detailed description of which was read to the Institute of Civil Engineers on the 10th of May, 1842, from whose abstract of their proceedings the following is copied verbatim.

"The mill described in the communication consists of one room, 396 feet long, by 216 feet wide, covering nearly two acres of ground. The roof is formed of brick-groined arches, 21 feet high, by 36 feet span, upon cast-iron pillars: an impermeable covering of coal-tar and lime is laid on a coating of rough plaster over the arches, and upon that a layer of earth eight inches thick, sown with grass. This immense room is lighted and ventilated by a series of skylights, 13 feet 6 inches in diameter, one in the centre of each arch. A vaulted cellar, with brick pillars, extends under the whole of the building, and contains the shafts for communicating the motion from a pair of engines, 100 horse power, to the machinery of the mill, the flues and steam-cases for warming and ventilating, the revolving fan for urging the air into the room, with the gas and water-pipes. The remainder of the space is appropriated for warehouses."

Here follow details of the heating and ventilating. The report then proceeds: "The total cost of the mill, including the ornamental stone front, was 27,443*l.*, which is stated to be about the same cost as that of a good fire-proof mill of the common plan; but as the mode of construction was novel to the workmen, it is probable that a second building of the kind would be less expensive."

During the discussion that followed the reading of the paper, Mr. Smith of Deanston stated: "that he had been the first to adopt this mode of construction in a weaving-shed of the extent of half an acre; the columns for carrying the arches were 30 feet apart, the skylights 8 feet in diameter; some of the arches were of brick, with stone springers; others were entirely built with rubble well grouted; which latter mode he found to succeed quite as well as brick." Mr. Smith then proceeded to explain how the roof was made quite waterproof and dry, and with what facility and economy the whole was ventilated and warmed. "With one ton of coal per week the shed could be kept at 50° during winter." "The cost was 30*s.* per yard of the are covered," or 3*s.* 4*d.* per foot, while it will be seen the Messrs. Marshall's mill cost nearly twice as much.

In answer to a question, Mr. Marshall explained that at first a few leaks had occurred near the skylights; but they had been easily repaired, and were now quite water-tight, which Mr. Combe confirmed, stating that "those had been easily repaired, and all were now perfectly secure."

In conclusion, Mr. Marshall "desired it to be borne in mind that the stone-cut front of the mill has greatly enhanced the cost, and this being the first building of the kind erected at Leeds, it was naturally more expensive than others would be."

The stone front alluded to in the above is of Egyptian architecture, three quarter columns, richly carved, supporting an Egyptian cornice, reeded, and with winged globes, and other equally incongruous but expensive ornaments, extending along the whole of one of the ends of the building; and I presume the above sum also includes an enlarged model of Cleopatra's Needle, which spouts dirty black smoke from its apex in a manner that would amaze the Rhamissidæ.

In adapting this room to the purposes of our library, the first thing that strikes us is that it is too low, and I therefore propose to raise the roof ten feet; and as a further security against fire, to substitute brick piers in cement, with a hollow cast-iron coring, for the iron pillars. The expense of these alterations is easily calculated, and would be less than 3000*l.*; but as we do not want, at present at least, "the handsome stone front," we might put it against this extra expense; but at the same time, as an institution of this sort would require a higher style of finish, and some more ornament internally than the mill, I will take the expense at 30,000*l.*

The superficial extent of floor in this room is 85,536, or more than twice that of the present library, the cubic contents 2,566,080 feet, or allowing 2¼ feet to each volume*, would contain, say one million of volumes, at an expense consequently of little more than sevenpence per volume, or less than a tenth part of the sum that it has cost to accommodate them in the present library. This is a startling economy: but the first saving is not always the best, and unless it can be shown that they are as well accommodated, it may not be expedient to adopt it. My own belief, however, is, that in every respect this new library would be preferable to the present one.

In the first place, it is more fire-proof, for as no wood or other combustible material whatever is used in its construction, not even cast-iron: the building could not be burnt or injured by fire. This is not the case with the present building, as the roof is composed principally of wood, the floors of wood and cast-iron; which last is now universally admitted to be a most treacherous and dangerous material in the event of a fire; and all the panelling of the ceiling is wood bracketings, of the most combustible nature, and from their position most dangerous. In the present instance the plaster would be laid directly on the brick vault, as the beauty of its form would require no assistance from any false form superadded. Its incombustibility is therefore at least one advantage gained.

A second is—that owing to the compactness of its form, and there being so little external wall, besides the unlimited means of openings in the roof—it would be far more easily warmed and ventilated than the present building.

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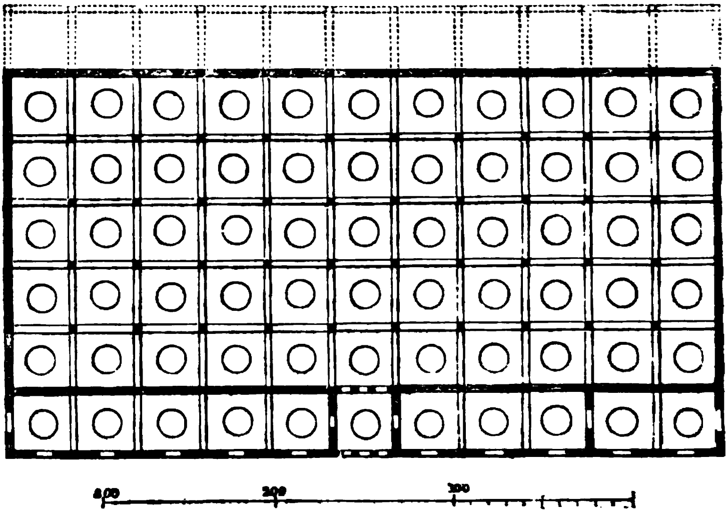
* According to the most exact calculation I can make, the cubic contents of the present library, including the King's, is 1,110,000 feet; so that if it will contain 500,000, the space allotted to each is 2·22 feet, or 2¼ nearly.

A third advantage is, that it could be much more easily and sufficiently lighted than the present building; for if 13-feet skylights were not sufficient, they might be made 20 or 25 feet: on the contrary, if this is thought too much, 10 feet might be adopted.

A fourth advantage is, that even with a million of volumes, no single book would be at a greater distance than 250 feet from the bar of the reading-room: the present extends beyond 300 feet both ways, and contains only half that number.

The last advantage I shall enumerate here, though I conceive it to be one of the most important, is, that a library constructed on this principle may be increased to any extent without either inconvenience or extra expense.

The mode in which I would propose to effect this is as follows: let us suppose, in the first instance, that the whole of the eleven vaults on one side are partitioned off into reading-rooms, officers' rooms, and offices, (as shown in the annexed diagram,) which would be the situation for them, as they would thus have side-lights as well as those in the roof, and some of them might thus be divided into two floors. Now, supposing it were ever wished to increase the library, all that would be required would be to erect a similar range on the opposite side (shown by the dotted lines). When they were complete and ready for occupation, all that would be required would be to remove



the furniture from one side of the library to the other, during one of the weeks it is closed for cleaning. The readers would have notice to enter by a door opposite to the one they were accustomed to; *ipso facto* accommodation for 150,000 volumes is added to the library; and this process may be repeated *ad infinitum* till the library contains two to ten millions of volumes instead of one; and all this without any further expense than the fixed price of sevenpence per volume, which we obtained in the first instance, or the new addition might at once be apportioned to the library, as this would come exactly to the same thing, unless, indeed, it were wished to centre the library with reference to some other building or object in its neighbourhood.

If we apply this plan to the purposes of a museum of natural history, I am unable to conceive anything so admirably adapted to the purpose. You have two acres of floor, on which you may arrange your kingdoms and classes in any form or according to any system you may think it best to adopt; and if the minerals and fossils are placed in the centre, the mammalia may be arranged on one side, the birds, reptiles, fishes, insects, &c., may follow one another in natural order, each class having exactly that extent of space you may think it requires or deserves; and with this inestimable advantage, that if you wish to increase any department, you may do so to any extent you please, without inconvenience, or without disturbing a single case or specimen contained in the original building: one compartment containing 1300 square feet may be added at any of the 34 points of the exterior, or two compartments, or three, just as wanted, and this without incurring any additional expense, beyond the 6*s.* or 6*s.* 6*d.* per square foot which the original building cost; and that this is not much, will be apparent when we remember that the present unextensible and inconvenient building cost 3*l.* 7*s.* per square foot of floor, or from 10 to 11 times as much as the proposed building.

As 21 feet is quite high enough for a museum of natural history, we shall not require to add anything to our estimate in this instance for raising the roof; and if we take credit, as before, for the "handsome stone front" not now required, and apply the money so saved to interior decorations, we shall have more than is needed for the purpose; so that this room ought not, under any circumstances, to cost more than the mill, or say

27,500*l.*; my own conviction is, that it could be erected for considerably less.

The remaining department to which we have to apply our model is that of antiquities. Here we should require to alter somewhat the form of our roof, though not of the floor, nor of the pillars or walls that support it; but though it might lead to some trouble in designing and adjusting the form of the vault, I do not conceive it would lead to any considerable additional expense, the same quantity of materials would suffice: the only thing is, that they must be differently disposed: but here you have the same freedom of adjustment as in the other departments: your divisions or parting walls, need never be exactly in the line of the pillars, or halfway between the skylights, but dropped from their northern edge; and you may have your rooms either with one dome, or two or three, or, in short, of any shape or size that best suits your own convenience. I would recommend some of the compartments, say the alternate ranges, being 21, the others 31 feet high, and the light introduced into the latter, not by a perpendicular skylight, but from the lunette in the northern face: by such an arrangement you might obtain any quantity and any form of light that best suited the peculiar class of sculpture to be placed under it.

Let us suppose that these arrangements would add 5000*l.* to the expense of our mill-room, (I would contract to make them for less,) and we have an aggregate sum of 90,000*l.* for our three rooms, to contain the whole collection of the Museum.

One objection is so certain to occur to every one, that I must not pass it over in silence. It will be said that what I have been proposing will form only a low unsightly building, without any architectural merit. With regard to the interior, I am certain that the objection does not apply, for no form of roof has yet been invented so beautiful or capable of every sort and variety of architectural effect as that of domes resting on pendentives; and whether used as it was by the Byzantine architects, who invented it, or by the eastern Saracens, who carried it to perfection, it is more beautiful than any other known form—certainly more so than the intersecting vaults of the Gothic architects or the flat coffered roofs of the Greeks. So that on this head I have no fears; and with regard to the exterior, I am prepared to meet the objection at once, by proposing to re-erect the 44 columns of the present portico in front of my museum; for one of the great advantages of this style is, that it is so utterly incongruous with anything in this country, or of this age, that it applies and is applied equally to a gaol, a palace, a church, a post-office, or museum, and certainly is quite as applicable to mine as to Sir Robert Smirke's. Indeed more so; for as I want no side-lights, I should be able to omit all these windows behind the portico, and so reproduce the Greek style in all that perfection of dismal purity which every educated admirer of classicality thinks so beautiful, and when I consider the enormous expense, and extent of misapplied ingenuity, that have been wasted at Liverpool on the east front of St. George's Hall, to produce this very effect of a columnar façade without windows, I am sure I deserve very great credit for pointing out how it might be done here. I should also avoid the meanness of running an entresole floor across some of my windows, as is done in the Museum, and which so strongly contrasts with the pretended magnificence of the pillars in front of them. Another advantage would be, that my building being so low, I should be enabled to hide it entirely by my false front, and would thus avoid that strange admixture of magnificence and meanness which disfigures the present façade when viewed in conjunction with the parts of the east and west fronts that are seen immediately in the rear of it.

I need not say that I would undertake to erect a very much handsomer and more suitable façade for a very much less sum of money, but as I am not prepared to present a design, I take this one as it stands, and putting it as before at 44,000*l.*, for which I hope every one will admit it may be erected, our museum would now cost us 134,000*l.*, or, to avoid all cavil, say 150,000*l.*, or one-fourth part of what the present one has cost. This, however, is not stating the case fairly, for the museum I am proposing possesses 256,600 square feet of flooring, the present one only 166,000, so that to produce a museum of the same extent would only cost 100,000*l.*, or one-sixth part of the sum that has been lavished on the present building; and I feel certain, that if judiciously carried out, the ratio of expense might be further decreased to a very considerable extent.

But allowing it to stand as it is, we have, with this economy, a building more beautiful, more convenient, more suitable for the purposes for which it is designed, in every respect, than the present one; and last, though not least, capable of indefinite extension.

This being the case, am I or am I not, justified in saying that the present buildings are about the most extravagant, and at the same time, the most inconvenient that could be designed for the purposes for which they were erected*?

Throughout the preceding description, I have adhered to one model, and that not a very artistic one, for the sake of making myself easily understood, and my calculations as simple as possible. I am far, however, from recommending it as the best that could be adopted under all circumstances; on the contrary, were I called on now to design such a building, or rather had I been in Sir Robert Smirke's place when the task was assigned to him, I should probably have recommended, what I may perhaps be able to make intelligible by a reference to a better known model than the Leed's mill. In the present instance, I will take the Farnese Palace at Rome; its façade, is a rectangle of about 200 feet in length by 100 in height, I would propose to re-erect it with a depth of 100 feet, of course increasing to a very considerable extent the size of the windows, so as to admit a sufficiency of light†. The experience of the north wing shows how easily this could be done. Across each end of the building I would place one of similar dimensions, so that the whole should have something of the form of the letter H. Its form, indeed, being very similar in outline of plan to the present front façade of the Museum, only extended from 370 to 400 feet. This building I would have made to consist of three honest stories, averaging 30 feet in height. The ground floor—one-half at least of which should be divided by an entresole into two stories, should contain the entrances, passages, receiving, sorting, cataloguing, and binding rooms, besides apartment for officers, offices, indeed, every accommodation required for such an establishment, besides reading-rooms, which could be provided to any desired extent.

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* If it is thought that my building would cover a greater space of ground, than would be available for the purpose, I can only say, that the present Museum premises contain above 338,100 square feet, exclusive of the land recently purchased at the south-east corner, which I believe extends to above 45,000 feet more, but its limits not being marked on any plan in my possession, I am not certain on this point; but be this as it may, there is room there for the buildings I am proposing and for an increase to the extent of 50 per cent. wthout purchasing another square foot of ground.

† In Mr. Barry's copy of this building, the Reform Club, he has adopted literally the window of his original, making the solids, or the spaces between the windows, double the voids or the openings; a proportion suited to the bright climate of Rome, and the bad glass they had to fill their windows with. It is, however, for that very reason unfitted for a London climate, and is throwing away our splendid plate glass, which is one of the most beautiful architectural inventions of the age. This, however, is called correct copying, and this silences all objection. To me, however, it appears that true correctness would consist in making the openings in the same ratio to the light in both cases. In London, I believe, that would be effected by making the voids equal to the solids, in nine cases out of ten, this appears to me, the least ratio that should be tolerated.

The first floor fitted up as a library would contain with ease, say half a million of volumes, with the usual proportion of manuscripts. The second floor, owing to its greater height, would contain, say 600,000 volumes, with a like proportion of MSS.*, and I would have allowed for a projection in the centre towards the north, to contain a third extension to a like extent, or allowing room for more than twice the collection contained in any library in the world.

For statue-galleries, I would have proposed a great central gallery nearly in the position, and on the plan, of the present Egyptian and Townley gallery; and opening into it on the right and left, I would have erected galleries branching out like the Lycian room, alternately high and low, as I shall explain presently in speaking of a new National Gallery; and building them only as required, I should have been able to provide at least three times the accommodation now afforded this department.

On the east side, I would have erected my natural history museum, on the plan of the Leeds mill: these two last, of course, communicating with the front building by passages, so as to prevent the necessity of going again into the open air after entering the building. If designed on this plan, the façade in the first place, would have been a far handsomer and more imposing structure, its height being, with roof and basement, about 125 feet, while that of the present one is only 66; and it would, besides, possess the immense advantage of being a true and honest building, representing what it is.

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* I need scarcely explain, that the communication between these floors and the reading and sorting rooms would be effected by means of lifts. A mechanical contrivance brought to great perfection in the manufacturing districts, and by means of which books could be lowered and raised with less labour and inconvenience to the attendants, than is necessary to convey them from one part of the building to another along the level floor.

The whole would have been somewhat more expensive than the one I have just been describing; but when completed, so as to contain three or four times the collection which the present edifice will accommodate, it would not cost so much as it has done; and I think there are few but must allow that it would be a far more convenient building for the purpose for which it is designed.

All this is, however, speculating on what might have been, but which is now impossible. The museum is built and finished, the money spent, and though I know it is very much the fashion in this country to build up apparently only for the sake of pulling down again, and this has already been practised in the British Museum to some extent, I am not about to propose any such expensive expedient. The practical question to which I wish to address myself, is, how to make the best of what we have got with the least possible extra expenditure of money; and it is to suggest means for doing this, that I write these pages. Before, however, proceeding to explain the means I propose for applying this principle to the Museum, I must say a few words regarding the National Gallery and Record Offices, which form part of my scheme, for without including them in my proposal, I do not see how anything can be effected.

THE NATIONAL GALLERY.

The National Gallery, as I before said, owes its existence to a suggestion of Mr. Wilkins, who, when the old Charing Cross Mews was pulled down, and a range of shops about to be erected on its site, waited on Lord Dover and Lord Aberdeen, and suggested to them the expediency of erecting a National Gallery on the spot. His advice was most fortunately adopted, and for saving our pictures from being stowed away in the ornithological galleries of the British Museum, and giving that department an independent existence, besides securing that site as national property, the nation ought to have voted him a statue. They have been more inclined to burn him in effigy.

That the building is not what it should be, is only too evident. But if any person can point to another architect of the day, who either has done anything better, or who, under the circumstances, could have done the thing as well, he has more knowledge of English architects and their works than I can pretend to. Great has been the storm of abuse, and many the proposals for amending what is wrong. The first is easy; but the latter is not so; and so far as my knowledge extends, the Gallery is as well now as it would be with any of the improvements I have seen suggested.

The truth of the matter is, that the task imposed on Wilkins, was one which rendered success impossible: he was given an immense length of façade to fill up, and allotted only a very niggardly sum of money for the purpose. He was given a set of columns, taken from another building, and told to fit them to this; he knew well enough that if he placed them on a higher stylobate than the one he used, he would dwarf them; if he placed an attic over them, he would not only be committing a solecism in Greek architecture, but crush them in effect; thus he could not raise the building even if the funds at his command had enabled him to do so. He was then ordered to leave two thoroughfares through his façade, so as to break it up more and more; and lastly, he was forced to set the whole building back, so as to prevent the possibility of lighting his back rooms*, in order to satisfy a clamour that he was hiding the very second class portico of St. Martin's Church; add to this the fundamental absurdity of the National Gallery being designed to look like a Greek temple, and it will be, I think, apparent, that nothing but failure could possibly ensue from the attempt. The blame of this failure, however, ought not to rest on the architect, but on those who misdirected him. If the aristocracy and upper classes of the kingdom insist on a man getting down on his hands and knees, and crawling on all-fours, they should not be allowed to turn roundon their victim, and tell him he is a bad pedestrian—and as they have often told architects—worse builders than the beasts. If they will let men use the intellects and the talents God gave them, they will soon see that the architects of this day can walk as far and as fast as those of any other time or nation. But if they insist on men doing what

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* These particulars are taken from Mr. Wilkin's evidence before the Commission of Fine Arts, in 1836. Question, 1383, et seq.

God decreed no man should do, they must be content with failure on failure for the present, and hopeless despair for the future. Poor Wilkins could not afford to stand erect on his own feet, so he fell on his knees as he was bid, and crawled—and the crowd laughed and hooted him to scorn.

So radically wrong does the whole arrangement of the National Gallery appear to be, that I am convinced there is no real remedy but pulling it down and rebuilding it from the foundation, if it is to be made a really national edifice, and worthy of the site on which it stands, which is the finest in the capital; but there is no hurry for this: the exterior is as good as that of most London edifices—better than many; and the interior is neither inconvenient nor badly lighted, and a very small sum of money, judiciously employed in painting and decoration, would remove at once the poverty-stricken look of the rooms, and fit them to receive the collection; and, by flooring over the entrance, which would not cost much, accommodation might at once be obtained for the Vernon collection, and for any extension the Gallery is likely to receive for some time. This at all events would suffice, till the project I am about to propose would be so far perfected, that the Gallery could be rebuilt without inconvenience or delay, though not, of course, without expense.

RECORD OFFICE.

The only other institution that now remains to be noticed is the National Record Office, which does not yet exist, but the public are now so convinced of the expediency, indeed, of the necessity of its establishment, that it may almost be considered as a thing that is, and I think there can be little doubt but that with the first gleam of financial prosperity, some steps will be taken to remedy the present very unsatisfactory mode of preserving one of our principal national treasures.

Various projects have, from time to time, been presented to the public for supplying this defect in our arrangements: none however of which have received either the sanction of public opinion, or the patronage of Government, and, consequently, it will be unnecessary to mention them here; and I shall confine my remarks to the last and best which was proposed by Mr.

James Pennethorne, the details of which are given in the Sixth Report of the Commissioners for Improving the Metropolis, printed in 1847, from which the following particulars are derived. This project has received the sanction of Government, and of the public, and steps would, I believe, have certainly been taken before this time to give effect to it, had not financial difficulties intervened, which have put a stop to this and many other useful projects; but it will no doubt be revived and carried into effect, unless something better is substituted.

The project is, to erect the National Record Office on the Rolls estate, a property belonging to the Crown, situated between Chancery-lane and Fetter-lane, towards their southern extremities; but as its area will not nearly suffice for the purpose, it is proposed to purchase a considerable extent of property, ranging from the Rolls estate to Fleet-street, so as to get the requisite area for the proposed building: on this space the office is to be erected, in plan something like an inverted L, each leg being about 500 feet in length, the one running north and south from Fleet-street, to contain the repositories for the Records; the other ranging from east to west, to contain the Searching Offices, Residences, Rolls Courts, &c.

The expense of the project is stated as follows (pp. 5 & 6):—

For the cost of the building .	175,000*l.*	
of fittings . . .	31,500	
		206,500
To purchase of properties . .	293,500	
Deduct probable return for ground rents	50,000	243,500
Total net cost		450.000*l.*

This is modified by Mr. Pennethorne apportioning 130,107*l.* of the above sum of 243,500*l.* to the Record Office, and the remainder, or 112,908*l.* to the improvement of thoroughfares, making the net expenses of the office 336,607*l.* This, however, is scarcely a fair way of viewing the question, because the widening of the lower part of Fetter-lane to sixty feet, while the northern portion remaining only twenty-five feet wide, and its line being removed eastward, are changes wholly caused by the building of the office, and the whole expense of which ought consequently to be debited to that project, for they never would have been dreamt of but for its convenience.

The street running east and west on the north side would be a great public convenience, if the whole of the line from St. Paul's, to Cary-street westward, could be carried out, but if it were done without reference to the Record Office, the net cost to the public would certainly not amount to 50,000*l.* at the outside, as most valuable frontages would be obtainable on both sides of the street; whereas, if the Office occupies the whole of the south side, as it does, according to Mr. Pennethorne's proposal, it must be debited, at least, with the loss it thus causes; deducting, however, this sum of 50,000*l.* from the above, we have 400,000*l.* for the net cost of the Office, to which we must add the value of the Rolls estate, which is used for this purpose. According to Mr. Cadogan, the estate would sell in the market from 100,000*l.* to 120,000*l.**, and as nearly the whole of it must be used for the purposes of the Office, we obtain a sum amounting to very nearly half a million of money for the project, always supposing the land could be purchased and the building erected for the sum estimated for; but as this has scarcely ever been the case in a single instance, we may safely add something for extras: and put down the net expense as amounting to 500,000*l.* at least, or in round numbers, say 300,000*l.* for the site, 200,000*l.* for the building; I think we may safely add, without the fittings.

Now this project appears to me just one of the pieces of wasteful extravagance, of which I have had so often to complain in the preceding pages, for I am convinced that a site as convenient in every respect might be obtained for 30,000*l.*, and I do think it, therefore, most uncalled for to spend 300,000*l.* for the purpose. Of course, if the Government have 270,000*l.* which they do not know what to do with, and which they wish to throw away, there can be no possible objection to their investing it in this manner, but when we think what effect that sum would have if properly spent in improving the collection of the British Museum and National Gallery, or in establishing libraries or galleries in the principal provincial cities of the kingdom, or in promoting education or scientific research, it is painful to think that for all these purposes the national exchequer is bankrupt, and a man only exposes himself to ridicule, who thinks of asking Government for a grant for them; but, on the contrary, when a scheme of this sort is brought forward, which benefits nobody, no objection is offered, and the money granted on the first convenient opportunity.

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* Report, Courts of Law and Equity, Ans. 1193.

Of all the edifices or institutions that belong or can belong to Government, no one can so well afford to be put into a corner as the National Record Office. According to Mr. Cole's evidence, in pleading in favour of his office, he states, that "the average number of searches in his own office is probably from 8 to 10 individual persons per day" (Ans. 164), or say about 3,000 during the year, whereas not less than 900,000 persons visit the British Museum per annum, so that there are three hundred reasons for placing such an institution in the most public situation possible, for one that can be urged in favour of devoting it to a Record Office; or if we take the reading-room of the Museum alone, the persons using it are 250 to 300 per diem, so that it would be expedient in the ratio of 25 or 30 to 1 to remove the library of that institution to this place, and give up its accommodation to the records. Or, to take a still stronger instance, nothing can be more inconvenient than the present site of the law courts at Westminster, and it has almost been determined to remove them to some situation in this neighbourhood. We have no return of the number of persons visiting the law courts, but they must, I think, be nearly as numerous as the visitors to the British Museum; but whether they are or not, the greater part of them are men whose time is most valuable, not only to themselves, but to the Government, and to the parties who employ them.

The parties using the Record Office probably do not receive 3000*l.* a-year altogether for the time they are employed in the searches; the persons using the law courts, including judges, barristers, solicitors, &c., certainly receive more than 300,000*l.* during the period they are employed within its walls; and their business is so important, that it may be a wise economy to spend 300,000*l.* in placing their buildings in a situation where even only a fraction of a day may be economised by these men; but if there is a class in the whole capital, to whom it is of slight importance whether the office they labour in, is situated a mile further east or west, than "the best possible site" it certainly is the consultors of our records.

Besides this consideration, I conceive that a Record Office ought to be as far removed as possible from the noise and dust of an enormous public thoroughfare; as far from the masses of old timber houses, which are ten times more combustible than those built within the last few years, and where a fire may one day overpower the engines; and lastly, as far as possible from the probable scene of any civil tumult or disturbance, or, in other words, as far as possible from Temple Bar.

It has been urged that the site of the Rolls estate is not convenient for the erection of law courts, and it has been proposed to purchase a site on the other side of Temple Bar for this purpose, at an expense of, say 300,000*l*. If we take credit for the value of the Rolls estate, this leaves 200,000*l*., so that, as far as expense goes, there is not much to choose between them, and it may be the most convenient, but I think it is at the same time a mistake to assert that the Rolls estate would not answer the purpose. Of course, if we determine that the law courts should be built in the model of the Parthenon, as Mr. Barry proposed, or to look like a Gothic cathedral, the Rolls estate will not suit; but if we choose to build them according to the dictates of common sense and good taste only, I do not think a better form could well be hit on, than that sketched out by Mr. Pennethorne for the Record Office, or one that would admit more easily of extension at any time that it might be required.

Before leaving this part of my subject, I must enter also my protest against the style of building it was proposed to adopt for the Office, which was to have been what is commonly called Elizabethan; a style which, though it takes a powerful hold on our imagination when mixed, as we often see it, "with old ancestral woods," time-stained and gray, hallowed by the recollections of former ages, and that tinge of beauty which time can give to even the vulgarest and most unworthy object;—yet it is a different thing to stick up a staring red brick edifice in a modern thoroughfare, where every detail of the building is not only coarse and vulgar, but as incongruous with the object of the edifice, as with the character of the age in which it is erected.

As a style, the Elizabethan is composed of corrupt Gothic, mixed with still more corrupt Roman architecture. It arose when the clergy and upper classes ceased to busy themselves with the art, and handed it over to the stone-mason and the carpenter, to make the best of it they could, at the least possible cost. They soon abandoned all the elegant mouldings and complicated but exquisite forms that had been produced by long ages of patient and persevering study, and adopted in their place such as could be easily described by a foot-rule and a pair of compasses; despising and trying to get rid of the style they were forced to use, and aiming at introducing in its place copies of the classical styles which were then coming into fashion. But as they had no knowledge of them, or of their true principles, the thing they admired fared as badly as the thing they despised, and that incongruous jumble of bad taste and vulgarity was produced which we call Elizabethan.

At all events, we are now spending nearly a million of money to reproduce, in the new Parliament Houses, Gothic mouldings and Gothic forms in all their purity. At the British Museum, we are spending a quarter of a million wholly for the sake of reproducing the Grecian forms and mouldings in their purity; and here we propose spending a considerable sum in using both these orders in their greatest possible state of corruption and impurity; as if, mixing together two corruptions, the result would be a perfection. As well might we try, by mixing two bad smells together, to compound a scent; or, by doing two foolish things, to produce a wise action.

Of course, if our wish is to turn the capital into a "hortus siccus" of dried specimens of the arts of other ages, it is true we ought to have a specimen of this strange hybrid. We have false Gothic, false Grecian, and false Roman specimens *ad nauseam*, and we are tired of them all. Perhaps an Elizabethan specimen might recal us to our senses; and if so, it would be meritorious. But if we would only at once determine on using our reason, we might begin the adornment of our capital without this last absurdity, and at once open a new career to this most unfortunate art.

One thing I am certain every architect will bear me out in asserting, that the plan proposed by Mr. Pennethorne would be a most expensive one for a brick building. A design comprising more than 150 bay-windows, besides innumerable breaks, angles, and returns, must be excessively expensive to construct; and when the utmost effect that can be obtained would be a certain extent of rude picturesqueness, I cannot but think the money would be very ill bestowed. I am perhaps not justified in even hinting at it, as I have not gone into any minute calculation on the subject; but I should be most exceedingly surprised if the edifice, as designed, were erected for anything like the sum estimated for. I should certainly be inclined to add 50 per cent.; but of this others are better judges than I can pretend to be.

PROPOSED IMPROVEMENTS.

These remarks might of course be extended to any length; but I believe I have in the preceding pages said enough to show that our metropolitan institutions of the class I have undertaken to treat of, are not designed according to any well-understood or enlarged view of the object for which they were required; nor have they been happily designed to suit that small portion of the public wants which was dimly perceived at the time they were undertaken; nor have they had the good fortune which sometimes attends even the worst designs of men—to fit by accident, a requirement their designer did not perceive.

Thus, however, they are; and the one mode of improving them which has yet been suggested is to patch and add to them, and to increase the means of accommodation—so as to still the outcry for the hour, totally regardless of the exegencies of the future, and unmindful of those demands which an enlightened policy with regard to these institutions would anticipate; instead of their lagging behind public opinion, as they have hitherto done, only forced forward by pressure from without, pushing them onward by a series of irregular movements, in harmony neither with the spirit of the time nor their own true interests.

It is to protest against this wasteful and inconvenient mode of patching up what is radically bad, that I have written these pages, and in the hope of inducing the public to begin *de novo* on some more comprehensive scheme, which shall put a stop for the future to that system of building up and pulling down again, and which shall enable these institutions always to meet the public demands to any extent that the furthest-seeing amongst us can conceive. The longer we persevere in our present course, the more inconvenient will our position become, and the more difficult as well as more expensive will it be to retract; every time we add to the existing edifices only increases our difficulties, and every year only complicates us more and more in a vicious circle, out of which we scarcely now see our way. But if we at once start afresh on an improved and enlarged scheme, we may at least be sure that every brick we place and every shilling we spend will be useful, not only to ourselves but to posterity. Although we cannot recall the money which has been wasted, nor undo what has been done, we may at least benefit by the experience we have gained, and strike out now into a new and onward path, which will lead us towards perfection.

Such a scheme cannot of course be matured at once, nor by one individual; but till something is sketched out, men do not see either what is wanted or what is wrong. And though I am far from being confident that what I am now going to propose is even the best that I could myself devise, with more time and leisure at my command, and access to better and more complete information on the subject than I now possess, still it is a scheme—one too that is practicable, and which would meet all our present wants: having it before them, a few honest criticisms and suggestions from those better qualified than myself, would remove many of its defects and improve its details; and when so amended, I do trust that either it, or some such scheme, will be determined on and persevered in, and this state of chaos and confusion put a stop to.

What I propose may be explained in a very few words. It is simply this:

In the first place, to remove entirely the sculpture, and the whole department of arts altogether from the British Museum, and to build galleries for its reception, either in the rear of the present National Gallery, or to rebuild that institution on some other spot capable of providing accommodation not only for the pictures, but also for the statues of the nation, so as to join these two departments and to make one great national repository of fine art.

In the second place, to remove also from the museum, the department of natural history. This may be effected either by sending the minerals and fossils, as afterwards to be explained, to the Museum of Economic Geology in Piccadilly, and erecting a separate institution for the specimens of animated nature, or by erecting a separate institution to contain the whole three kingdoms.

Lastly, by removing all the records to the British Museum, converting the present statue galleries into record depositories, for which they seem to me as admirably adapted as they are ill suited to the purposes for which they are now applied: thus making the British Museum the great depository of all the printed and written treasures of the nation.

We should then have three distinct, well defined, and appropriate departments, instead of the present jumble; and all this could, I believe, be effected for the same sum of money as we are now prepared to devote to accommodate one department alone, leaving the others in their present deplorable state.

In explaining these propositions a little more in detail, I shall begin first with the British Museum. I would not propose either to add one brick to the existing edifice, or to pull down or alter one, except, perhaps, that as a further security against fire, I would take up all wooden floors throughout the building, and replace them with slate or some incombustible material. I would, however, add to it by erecting in the centre of the court-yard a building, either 175 by 105, or 150 by 90, as shown on the plan, or of any dimension between these two that may be determined on. Such an erection would, of course, interfere with the effect the architect wished to produce when he designed the court, but not I conceive to any material extent, as it would not be more than 30 feet in height, while the buildings around it are more than double that, so that the capitals and columns would be seen over it, and a space of at least 60 feet would be left all round between the two buildings, which is amply sufficient for the effect of a façade of the same height. The central edifice would, of course, be designed so as to accord in style with the main building, and if this was done with taste, my own impression is, that the effect of the court-yard would be more beautiful, certainly more picturesque with it than it is now without it. It would be connected with each of the four fronts surrounding it, by glazed galleries composed wholly, like the building itself, of incombustible materials.

This new edifice I propose to devote wholly to the public, making it the reading-room and search-office of the institution.

One of the first advantages gained by this arrangement, would be that the books, MSS., and records, would all be nearer the reading-room than they are at present.

A second would be, that this edifice could be perfectly lighted, partly by means of skylights, and partly by side lights, both of which may be obtained to any extent that may be desired; it could also be more easily and perfectly ventilated from its isolated position, and open fires might also be used to a considerable extent, without danger. It might also with perfect safety be lighted with gas, and thus afford readers the convenience of reading in the evenings, of which they are at present deprived, though I admit that under the present arrangements it could not be allowed.

If this one were adopted, what I would propose would be, that the library should close, as at present, at four o'clock in winter, and say five, instead of seven, in summer, after which no books should be given out, on any pretence; but readers should have the privilege of continuing their studies till, say eight or nine, or any hour that may be determined upon; this would be a relief to the officers, and a great boon to the public, and I do not conceive any inconvenience would result to them from the library being closed, as they can easily get out, before the appointed hour, as many works as they wish for, or are likely to require; and in the event of the reading-rooms being used by any one, whose avocations did not admit of his ever attending before five, all that would be required would be, that he should attend one evening, prepare his tickets, and give them to the attendant appointed for that purpose, with a request that he would have the works ready for him in the reading-room for the next evening.

With proper ventilation in the roof, and proper care in the construction of the building, I do not conceive that it would be possible either to burn or blow it up, and its furniture inside might be burnt to cinders—though that would not be easy,—without its affecting in any way the rest of the edifice, or of the collections, and with anything like proper precaution, this contingency is so remote, that it need scarcely enter into any calculation.

I would not propose to keep any part of the collection in this edifice, unless it were the duplicates, amounting to about

52,000 volumes, and some works of reference, such as encyclopædias, dictionaries, &c., which are of small value, and could easily be replaced. Their being placed here would relieve the great library, and their loss, in case of accident, of no great importance; supposing they amounted altogether to 70,000 or 80,000 volumes, this would afford considerable relief, and would make in itself a very tolerable library, to which the public would have access after the great library was closed. It has also occurred to me that *this* library might be lent out to students, in their own homes, under certain restrictions; but I am not prepared to say this should be done. If, however, it could be done, it would be a most valuable addition to the usefulness of the institution, and one that ought not to be overlooked if it could be attained with safety to the general collection.

The great advantage, however, would be the increase of accommodation, as this room would cover from 18,500 to 13,500 feet, whereas, in the present rooms there are only 4,200; and as the searchers are to the readers in the ratio of about twenty-five to one, if we allow one, say one-sixth of the space for the record department, we have still nearly four times the space for readers which we had in the old rooms; and owing to the superior mode of lighting, we may, I think, fairly say more than four times the available space, or room for at least 1000 readers at any and the same time.

The mode in which I would construct the interior would be something of the Leeds mill model. The exterior, however, would require to be ornamented throughout, but, taking it altogether, with galleries of communication, and other appurtenances, 40,000*l.* to 50,000*l.* ought to do more than cover the whole expense.

In proposing to convert the present statue galleries into record depositories, I shall be met at once by an objection founded on Mr. Braidwood's report* to the Record Commission, which seems to have been adopted by them, wherein he recommends small rooms not exceeding 6,885 feet cube, and with open fireplaces. I have read the letter most carefully, and with all due deference to such an authority, cannot but suggest that his reasoning is not definitive; for though I do not doubt but that an open fire, when properly attended to by a careful intelligent man, may be the safest arrangement, still, in an edifice with 142 open fireplaces, there must be a carrying about of coals, kindling of lucifer matches, and a cleaning of grates by candlelight in winter, and fifty arrangements which throw the responsibility on the personnel to an extent that seems to me far from safe. Besides that, in so many apartments with closed doors, great mischief may be done before danger is suspected, and the records be smouldering at such a heat that an open door may cause a sudden ignition, the effects of which it is difficult to foresee. It would, however, be out of place to enter into the question here, and I will merely state that, after giving the question the maturest consideration, I feel convinced that by heating the museum-rooms wholly with hot water in pipes, properly isolated, which, I believe, is to a great extent done already, and by dividing the galleries into compartments by projecting the present pilasters to the extent of about fifteen feet from the wall, and built wholly of brickwork, by removing all wood-work from the ceiling, and using only metal for the racks and cases, these rooms might be made as fire-proof as any building almost can be made, while the fewness and height of the openings, the general solidity of the building, its being so far removed from other combustible buildings, and from thoroughfares, would with the precautions above pointed out, render it far more fire-proof than the edifice proposed for the reception of the records on the Rolls estate; and I think I could satisfy Mr. Braidwood and the Commission on this head, if it were thought worth while to make the requisite calculations and drawings for the purpose.

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* Appendix C, in Sixth Report of Commissioners for the Metropolitan Improvement.

With regard to the extent of accommodation that could be obtained, Mr. Pennethorne states that of his proposed building as follows:—

	Cubic contents.
71 rooms on ground-floor - - - -	527·175 feet
71 do. on one-pair do. - - - -	527·175 „
	1·054·350 „
71 rooms on basement - - - - -	316·305 „
	1·370·655

Whereas the sculpture galleries of the Museum would afford

on the ground-floor say	900,000 feet
on the one-pair do.	440,000 „
	„
	1,340,000 „
and in the basement say	360,000 „
	1,700·000 „

These, of course, will be understood to be mere approximations, as I have not the materials for exactness at hand, but I believe them to be rather under the truth than above it.

This would, I believe, suffice not only for all the records at present accumulated in the different offices, but also for the accumulations for a very considerable period of time.

If new courts of law are erected, which I believe will certainly be the case before long, it would undoubtedly be expedient to provide every court with a record-office, to keep at least a certain portion of its own records; at present, the plan is to preserve them in the court to which they belong for twenty years, and then to hand them over to the Master of the Rolls for preservation in the offices over which he has control. If proper accommodation were provided, I feel convinced it would be expedient to extend this term to forty or perhaps fifty years, which could be done at very little additional expense; and if a portion of the Parliamentary records were in like manner kept in the New Houses, for which, accommodation has, I believe, been arranged, the Museum buildings would contain with facility all the accumulations of the next 100 years, and there is abundance of space to the westward of the present buildings, which could be purchased at a cheap rate—for the property is far from valuable—which would allow of extensions to any extent that might be deemed advisable.

The mode in which I would proceed to carry this proposal into effect would be, in the first place, to fit up the new Townley gallery and the rooms over it—both of which are at present unfinished—as a record office; and would remove into those rooms, when ready, whatever portion of the records it was determined should permanently occupy that portion of the building. At the same time, I would proceed at once to erect the central building, to be occupied eventually as reading-rooms;

and when it was complete, I would remove into it the whole of the remaining records. It contains more than 600,000 cubic feet, and is therefore more than sufficient for this purpose. They must, of course, be here accommodated in a temporary manner, viz. in the presses and on the racks at present used for that purpose; and as the sculpture was moved out of the Museum, the records would be transferred to the places they are intended to occupy permanently. One great advantage of this arrangement would be, that in less than two years from this time the whole of the records would be collected, and arranged in fire-proof, well-aired, and well-ventilated receptacles, where they could be safely preserved and easily consulted; and all this at an expense not exceeding 50,000*l.*, exclusive, of course, of fittings, which I specially avoid estimating for, at any time, as they are nearly the same for all buildings, while it is most difficult to guess with anything like certainty what they may cost beforehand.

I need scarcely point out how great a convenience it would be, to persons using the records for the purposes of historical research to have the library of the Museum, and the Record Office opening into the same reading-rooms; or the almost self-evident propriety of sending the remainder of the records to an institution that already contains a considerable portion of them, and some of these the most valuable we possess; not to mention the general homogeneity—if I may use the expression—that would thus pervade the whole collection contained in the building.

If any objection is raised with regard to the rolls thus passing from the charge of their official guardian, it is easily obviated by allowing this to remain exactly as it is at present, or to modify it to any extent that may be deemed expedient. The apartments now occupied by the keepers of the antiquities and other departments vacated, would of course be ceded to the Master of the Rolls or his deputy; and no interference of the other trustees need be allowed, but the two departments of the library and records kept as perfectly distinct as if situated in buildings remote from one another. I am convinced, that even if this were thought necessary at first, it would not be long before a partial amalgamation of the trusts would be decided upon; but this is a matter of detail I have at present no business with; and I merely allude to it, to meet a possible objection that may be suggested.

Were this plan adopted in the mode I am proposing, it would admit of the library containing a million of volumes of printed books, and a proportionate increase in the manuscripts, or double what it now will accommodate; and considering that the largest library known,—that at Paris,—only professes to contain about 700,000 volumes, and of these perhaps 20 to 30 per cent. are duplicates, it may be looking far enough into the future to provide for such an increase as is here allowed for. When, however, we recollect that at the end of the last century there was no library in Europe containing 200,000 volumes*, and that now we have learnt in less than fifty years to despise such a collection as altogether unworthy of even a second class state, I should have wished to design the Museum library so as to be capable of containing at least two million of volumes, or more than that if required; and I should wish the design for the Record Office to be made on such a scale, that it should contain the accumulation of a thousand years instead of one hundred.

These desiderata may, however, I believe, be attained without any extra expense by the project I am now propounding. As stated above, I believe the arrangements proposed will carry us safely over a hundred years, or till 1950. It will then be for the trustees, or rather the nation, to decide which department shall give way. Supposing it is determined that it shall be the library, the space now occupied by the books would, with the least possible change, be ready to receive the additional records, and then, we should thus have Mr. Cole's beau ideal of a Record Office, an isolated quadrangle, with the offices in the centre†. Or supposing it is determined that the records shall be removed to some other building, the offices that contain them would, with the smallest possible alteration in the form of the shelves, become at once as convenient a library as any other part of the edifice.

Such a change as this is a very different thing from the building up and pulling down plan practised in the case of the old Townley, and to be practised on the present National Gallery; not a brick is touched by the process. The collections are merely removed to what is virtually an addition, obtained without any change in the existing buildings, and but a very slight change in the fittings, so similar are the collections and the accommodation they require; and it will be observed besides, that from the proposed situation of the reading rooms in the centre of the whole, that they are equally convenient, whether the whole be a library or a record office, or whether these two departments be lodged in opposite wings of the building.

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* See Panizzi's, Evidence before Committee, 1836, Ans. 4,800, &c.

† See his Evidence in Sixth Report of the Commission of Metropolitan Improvements, ans. 130 And 134.

We have now, therefore, an extension, without altering or pulling down a brick of the present building, equal to the accommodation of two millions of volumes with the usual proportion of manuscripts; or we have accommodation for our records for four or five hundred years at least; and this is, practically, looking as far forward as there is perhaps any necessity for at the present moment.

With regard to the Mineralogical Collection, my own impression is, that the best plan would be to remove it to Piccadilly, and amalgamate it with the Museum of Economic Geology. The present edifice cost, I believe, 30,000*l.*, another similar to this, situated next St. James's Church, would therefore cost about the same sum, or probably a little more, as it would have an additional frontage, and we should require a centre to connect the two wings, costing say 10,000*l.*, or for the whole about 50,000*l.* Thus arranged, the building would not only contain the present collection, but would admit of its being doubled, and if further extensions were deemed requisite, they could be obtained to the eastward, by pulling down the houses between the present building and the adjoining court, called Eagle Place.

If this were done some ten or twelve years hence, it would admit of the library accommodation of the Museum being extended so as to allow of its containing about 200,000 volumes in addition to what the present rooms will accommodate, which would carry us on for about thirty or fifty years, from this time, when an extension to a similar amount may be obtained by removing the Zoological Collection, to some other edifice, to be erected to contain it. We have no institution with which it could be amalgamated, it is in consequence difficult to say either where it should be placed, or what the expense of removing it would be. Could such premises as those, occupied by Burlington or Devonshire Houses, be obtained for a site, or indeed any nobleman's mansion of the first class, which is by no means improbable, considering the tendency to migrate westward, the ground they stand on would be admirably adapted for the purpose, or a site may be obtained at less expense by taking advantage of a fire, or the opening of a new street through some worthless neighbourhood, none for instance, would have been better than St. Giles, and others may turn up in the next fifty years, as suitable, if Government would only watch the opportunity

As the building would be designed as nearly as possible on the Leeds mill plan, it ought, under no circumstances to cost 50,000*l.*, and if we add 30,000*l.* for a site, say 80,000*l.* for this department.

It would, perhaps, be more economical if these two last departments, were kept together and accommodated in one edifice as at present. If for instance, the last named required 80,000*l.* by itself, it might easily be extended to contain both, by adding 20,000*l.* to that sum, instead of 80,000*l.* + 50,000*l.*, as I am estimating them at according to the above scheme. But I am of course, merely estimating in the roughest mode, as it is by no means determined how any of the changes I am recommending shall take place, if they take place at all; and till this is determined upon, of course any estimate must be the merest guess possible; but I believe, I am near enough the truth for illustration, which is all that is here required.

NEW NATIONAL GALLERY.

To complete the task I have undertaken, it only now remains to say what I propose doing with the National Gallery, and how I intend providing accommodation for the sculpture and antiquities removed from the British Museum.

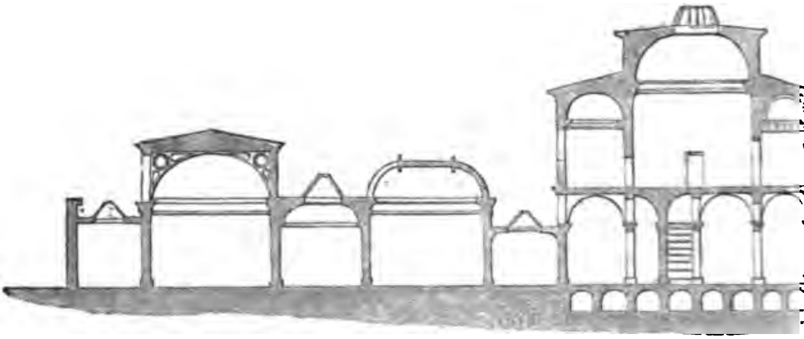
In the first place, then, I entirely concur with the Report from the Select Committee on Works of Art presented to the House of Commons on 1st September, 1848, in which they most strongly insist that the present site in Trafalgar-square, is the very best the capital affords for this purpose. To render it, however, available for a gallery of art, in the true sense of the term, the first thing requisite is that the barracks in the rear of it must be given up, and the troops now lodged there, must be accommodated elsewhere; I am not aware whether or not this will be an insuperable objection, or whether it will be ceded at once: my own belief is that Government ought not to hesitate about it, for I think it evident that the troops could be more conveniently lodged in the Wellington Barracks than they now are. We are now spending a very large sum of money in making a street through Westminster, so as to let air and light into that pestifierous neighbourhood; but I conceive it to be almost more important than this, to pull down the wretched tenements between the barracks and York-street, as the existence of such mean and dirty hovels within a musket shot of the palace is a nuisance that ought not to be tolerated; if they were removed, and a new wing to the barracks erected in their stead, every party would, I conceive, be the gainers.

I can easily understand that before the establishment of the London police, it might be considered important to have detachments of troops scattered about the town; but with the perfect organization of that force, I cannot conceive any circumstance which should make it necessary to call out the military so suddenly, that it would be of importance to have them in Trafalgar-square rather than in barracks less than a quarter of an hour's march from that spot.

It can only be in very extreme cases, that the military can be called on to act in London, and in such a case, I conceive a commander would, if suddenly called upon, rather have his troops concentrated on one spot than scattered in small detachments over the town. If the disturbance is foreseen, it is little matter where the troops actually reside, they will be posted where their services are most likely to be required, and such a building as I am proposing to erect would be as convenient for that purpose as the barracks themselves. But could a better position be chosen in which to concentrate the head quarters of the guards than the Wellington Barracks, in the immediate proximity of the Palace, and in sight of the Horse Guards, the Parliament Houses, and almost all the public offices? The question must be decided by military men, but my own impression is that the arrangement would be a desirable one, even in a military point of view. If, however, it is decided that they cannot be removed, we must look elsewhere for our gallery; but the proposition seems so reasonable, that I will not doubt it being conceded, though I shall at the end of this chapter offer a suggestion or two in the event of my being mistaken on this head.

I assume, for I have no details to justify any minute calculation on the point, that the new wing to the Wellington Barracks would cost 30,000*l.*, for this sum, therefore, we have purchased the best site in London for our purposes.

The mode in which I would propose to avail myself of it, will be best explained by the accompanying plate, which, however, I trust no one will consider as either a carefully studied or finished design for the purpose, or such a one as I would myself wish to see carried into effect; it is a mere diagram, meant to be explanatory of the text, and it will, I believe, be found quite sufficient for the purpose: it neither is, nor pretends to be, anything more. I need scarcely add, that the same remark applies to the section, (woodcut,) it too is a mere explanatory diagram, not a design.



I would first propose to erect the great western transverse gallery running north and south, and the galleries branching from it to the eastward, occupying the whole of the barrack premises. The great gallery would be two stories high, and would contain on its ground floor the larger antiquities, such as the Lycian tombs, one on each side of the entrance to the Lycian gallery. The two great Egyptian colossi, one on each side of the entrance to the Egyptian gallery; Layard's winged bulls, at the entrance to the Assyrian gallery, and so on, reserving it for colossi, statues, obelisks, and other antiquities, more remarkable for their size or curiosity than their art. The disposition of the other galleries, their size, form, and mode of being lighted, would depend wholly on a careful study of the sculpture to be placed in them, while the minor antiquities would be placed in the smaller galleries on each side of the great ones, so as to have the whole,

Egyptian, Grecian, or Roman collections, arranged together as a whole, not scattered about as they now are.

One or more of these side galleries might have two stories, and rooms for officers might be provided to any extent: some are indicated on the plan, to the westward.

If built on something like this plan, the galleries on the barrack premises would contain between 50,000 and 60,000 square feet of floor, and consequently more space than is allotted to this department in the Museum, so that the whole collection might be removed into them at once as soon as they were finished.

When extensions were required, they could be obtained as cheaply as in any situation in the neighbourhood, by pulling down the old decayed tenements between the great transverse gallery, and Whitcomb-street, and Dorset-place. This need, however, only be done as extensions are required, and without altering even the arrangements of those already erected, for supposing the three great galleries to the eastward were appropriated to Egyptian, Grecian, and Roman sculpture—either of the departments may be extended to the westward, across the great gallery, to exactly the extent required, or the Assyrian may form the pendant to the Egyptian, or indeed, any arrangement that is most suitable, may be adopted, there is nothing to tie the hands here, either externally or internally, at any time the architect is perfectly free to do as he thinks best. A third extension may be obtained by appropriating the site of St. Martin's parochial buildings, and erecting there the second, or eastern transverse gallery, with those to the eastward of it. This done, the sculpture galleries would cover more than 200,000 square feet of floor, or more than four times the extent of accommodation afforded by the buildings of the present Museum, and this I conceive to be quite enough for the purpose, for though books are a necessity, statues are a luxury, and a well selected collection, four times the extent of the present one, would be more desirable than a chaos of ten times the extent. Indeed, it is easy to limit the extent to which a sculpture gallery should go, though it is impossible to foresee what number of books may be required, and I therefore conceive that in providing space equal to more than four times the extent allowed in the British Museum, I am providing accommodation for as large a collection of sculpture and antiquities as it may ever be necessary to collect together in one building.

At present, however, I am only contending for the requirements of the next fifty years, and I conceive I am making ample allowance, if I admit of the present collection being doubled in that time.

The great western gallery and the side galleries on the east, and half of those on the west, would suffice to contain all this, and those I conceive could certainly be erected for less than 200,000*l.* as there are no exterior faces which would require ornament, and very few walls which are not party walls, and consequently do double duty, no court-yards or vacant spaces, but everything as compact as can be, consequently, the smallest possible quantity of materials will provide the greatest possible amount of accommodation, and that at the least possible expense.

What I would propose with regard to the pictures, would be, at once to roof over the entrance halls of the present galleries on the same level with the floors of the other apartments, this would give a room 100 feet long by 50 broad, except at the centre and ends, and would be by far the handsomest room in the gallery. The roof would, of course, require to be altered, and at the same time the central dome might be modified, together with the centre part of the front, so as to give it some more elevation. These changes would not cost 10,000*l.* and would at once provide accommodation for the Vernon collection and all the pictures of the British school the gallery contains; this done, we have room for an increase to the extent say of 25 to 50 per cent. on the present collection, which will suffice, I fear, for a longer time than is at all desirable.

The next step would be to put an end to the disputes between the Academy and the Government and public, by providing them with accommodation elsewhere. The Academy would, I am convinced, be too glad to accede to any arrangement of the sort, and it would be fairer to other younger societies and more satisfactory to the public in general, if they were to be provided with an academy, the property of which was vested in themselves; leaving, of course, the connection with their royal patron exactly as it is, and their constitution exactly what they choose to make it; merely putting a stop to the present anomaly of a public body refusing all public control, and receiving in the shape of rent, a large annual public subsidy. They, however, from long possession, have acquired a clear claim to compensation, if turned out; but I think 30,000 or 40,000*l*. would smooth over all difficulties, and as it would double the accommodation of the National Gallery, it would be by far the cheapest mode of going to work that could be divised. These rooms would require to be altered and decorated before being used for national purposes—but the whole of these arrangements ought not to cost more than 50,000*l*., and this would allow of our accumulating a very handsome collection of pictures, so large, indeed, that it would be a question whether it would not be more expedient to weed it, than to extend it. For myself, I would rather see a collection which would contain 500 really fine pictures, than one containing 1000, of which one-half or two-thirds were of questionable merit.

This arrangement would provide largely for the exigences of the remainder of the century—which is what I am now trying to provide for. I myself would, of course, rather see the present building pulled down and a new one built in its place. If we have money to throw away, I do not think we can employ it better; but while so many other useful institutions are languishing for want of money, and the Gallery itself is making no progress from this cause, I cannot but regard it as wasteful extravagance to pull down a building that answers our purpose, to supply its place by another. I would rather, for instance, see 100,000*l*. spent in the purchase of pictures than on a design, which, after all, may be no better than the present one; judging at least from what has lately been done in the capital, I think we may reasonably fear, that what we might substitute will be far worse than what we have, for neither are the public sufficiently educated to judge of what the design should be, or what is good beforehand; nor are the architects sufficiently awake to the exigencies of the case, to make a design which shall be permanently pleasing. We should not now, perhaps, have a pure Greek temple design, but would a Tudor, or a cinque cento gallery be much better? if we must have one of these, I for one would far rather prefer what we have, bad as it is.

My plan, however, provides for its being rebuilt whenever this is deemed requisite, but only by degrees, and as required. The rebuilding would, for instance, begin at Dorset-place, at the extreme western corner, and proceed to the north-east corner in St. Martin's-lane, as additional accommodation is required: fifty years might be employed in doing this, without inconvenience, or it might be done at once if thought necessary.

It will be observed that in the section (woodcut 2) I have copied very closely the arrangement of the Munich Pinacothek, for the upper story of my proposed picture gallery. I have done so, because I am convinced it is the best arranged and the best lighted gallery in Europe, but there are many of its details and minor arrangements that would require reconsideration before being repeated, though they are not perhaps sufficiently important to be dwelt on here. The basement however, of that institution is entirely thrown away. In the present instance, I propose to construct a gallery running its whole length and forty-five feet in depth, facing the south, to be used as the library and print room of the institution, and generally to contain the curiosities of the class now deposited in the print room of the Museum, and in the rear of this, lighted, from the north, I propose constructing a great gallery, thirty feet wide, to contain a collection of casts, or it may be of modern sculpture, and which, at the same time, shall form a gallery of communication, throughout the whole length of the building from east to west.

In the design there are three places shewn, where the public entrance, may be placed. If it is determined to have but one entrance, it of course should be in the centre where the portico now is. If two, one should be placed on the angle next St. Martin's Church, the other opposite the end of the great western transverse gallery: in this case, there would not, or rather should not, be one in the centre, though there may be all three if thought necessary. Myself, I would recommend two, as most convenient in an edifice where exhibitions for which the public may pay on entering may be located, as well as galleries, to which the public should have access without paying.

The entrances for sculpture and heavy articles, would of course be at the north ends of the great Transverse galleries, where they would be most conveniently situated for the purpose, besides being on a level with the street, on which they open.

It is not perhaps, necessary, to say more now in explanation of such a sketch, as the lithograph itself will show the proposed arrangement better than words can do; the only defect that cannot well be got over is, that if placed in this site the galleries do not admit of *unlimited* extension. It is true, that as I have arranged them they will contain a larger collection than is possessed either by the Louvre or the Vatican, and altogether I think this sufficient. The want of power to extend to an unlimited extent would be intolerable in a Library, Record Office, or a Museum of Natural History, as we never can forsee how much space we may be called on to provide ultimately for these objects; but if we possessed for instance, a very large collection of pictures, it is by no means clear to me, that it would not be expedient to place them in two galleries in different parts of the town, or to endow provincial galleries with a portion of our wealth in this respect, or lastly to exchange a number of inferior pictures for a few of a better quality, so as to make the collection more select. We can, in short, almost arbitrarily determine the number of works of art we wish to have in an institution, though we never can do this with objects of science, so that I look on the ultimate limitation of the National Gallery, as an objection that need not deter us from using the site here chosen.

Supposing, however, that from some cause or other it is found that the site here pointed out is not available for the purposes of such a national gallery as I have been proposing, I would much rather see a somewhat inferior site fixed upon, than see the collection kept separate, where neither amalgamation nor extension were available.

The next best in the capital would probably be that of St. James's Palace, and by a little management that might have been, or may be now, available for the purpose. Supposing, for instance, that when the recent alterations of Buckingham Palace were determined upon, the Parliament had agreed to grant an extra 100,000*l.* to make the addition of such a character that it should contain, not only the increased domestic accommodation required, but also a suite of public apartments worthy of the sovereign of Great Britain, it might not only have been made an ornament to the metropolis, but also so much more convenient to the sovereign in every respect, that she would have been only too glad to resign the ugly old brick edifice, in exchange for such a new palace.

Even now I cannot but think that before many years are over the nation will be called upon to make some such bargain. The new buildings of the Palace are not only so hideously ugly, that I am sure both the sovereign and the people would be most happy to get rid of them. But from the lowness of some of the roofs, the smallness of some of the windows, and other unpalatial defects, they must be most inconvenient, besides the unpardonable mistake in such a climate, and such a situation of enclosing a small, deep, court-yard, so as to engender gloom and damp, to what I should conceive to be an intolerable extent. All this surely will not long be tolerated, but a new palace be demanded, and if so, the site will hardly be that of St. James's; but if a second edifice is erected, either in conjunction with Buckingham Palace, or elsewhere; if the purposes to which St. James's is now applied are provided for in the new edifice, there can be no difficulty in its being given up to the nation for a gallery, or any other purpose*.

Architecturally, it would not be nearly so good a site as that in Trafalgar Square; not only because its principal façade faces the north, which is always objectionable, but because it is looked down upon from the point from which it is most seen, so that without such elevation being given to it, as is almost incompatible with a gallery, it would never possess the dignity a much lower edifice would command on the site of the present gallery. Another inconvenience would be, that it must have four architectural façades, and would look incomplete and unfinished till the whole were erected, which would add most materially to the expense. Another objection would be, that the north light being the one required for sculpture more than for paintings, the sculpture gallery ought to be next the street, the picture gallery next the park, which would introduce a new and most impracticable element of difficulty into the architectural treatment of the whole.

All these objections could of course be surmounted by taste and judgment; but as scarcely one of them applies to the other site, I think there can be little doubt but that it is the best;

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* See Appendix E.

and though, so far as I know, this is the second best, there is a vast difference between the two; the one compensating element being, that this is the most extensive, and, if Marlborough House were ultimately allowed to lapse into it, it would be more extensive than any probable wants of the nation would ever require.

I do not think there would be any difficulty in arranging the trusts of these institutions, so as to meet easily the exigencies of these new distributions of the departments. The Trustees of the British Museum are now almost virtually trustees of the National Gallery, because their pictures are placed there, and they might as well have charge of the whole as of a part; this, however, is not what I propose, but I would amalgamate the two boards, adding the one to the other; and I would also add to this united trust, as I before hinted, the presidents of some twenty of the learned societies of London. The Government or Her Majesty to be the judge which societies should be admitted to the privilege, and retaining the power of revoking it at pleasure. I would also add certain officers from the London University, and increase the number of elected trustees from among the most distinguished scientific men of the day, so as to make up the united board to at least 100 members.

Out of this legislative board, if I may so call it, I would propose to select executive sub-committees to superintend the separate departments, whose proceedings would of course be controlled by the general body, under whose advice and superintendence they would act.

Apartments should be provided for them in the new buildings in Trafalgar Square, where they would have a secretariat and offices of their own.

Arranged in this way, I believe it would be easier for such a body to superintend the national collections if placed in different buildings, than they can now do when they are for the most part jumbled together in one, and where they have to contend with the jealousy of officers, the clashing of interests, and the general ill-understood subordination of officers and departments to one another. All which, with many other inconveniences, exist at present, some I believe inseparable from such an ill-digested jumble as at present exists.

These, however, as well as fifty other details, would require far more space and time to develope than it is worth while I should bestow on them here, while it is uncertain that the project will be entertained at all. I believe I have said enough to make the outline of my project intelligible to any one, and to enable every one to judge of its feasibility or otherwise. If further information is asked for, I shall be only too happy to afford it to the best of my ability, or to fill up in detail any part of the outline which may seem to require such pains being bestowed upon it.

Before concluding, however, I may as well resume the expense of my project, which in the aggregate amounts to almost half a million of money thus:—

New Reading Room at British Museum, and alterations, say . .		50,000*l.*
New Mineralogical Museum . .	50,000	
New Zoological Museum if separate	80,000	
		130,000
Or if these are placed in the same building		100,000
New wing to Wellington Barracks		30,000
New Sculpture Galleries . .		200,000
Alterations in National Gallery and bonus to Academy . . .		50,000

Say 430,000 or 460,000.*l.*

There are, therefore, two projects at this moment before the public. The first of which has received the sanction of the Government and of the public, and unless some better is proposed, will be carried into effect on the first convenient occasion.

It consists in erecting a Record Office on the Rolls estate at an expense of from 450,000*l.* to 500,000*l.*, the whole of which money would be required in ten years at the utmost, as not one brick could be laid on the ground till the whole site was purchased and paid for, and it could not take more than eight or nine years after the building was commenced, to complete it.

The one collateral advantage gained by this project is the widening the lower part of Fetter Lane, which I maintain to be utterly useless for any purpose of traffic or ornament; and it leaves the British Museum and National Gallery exactly as they are, in their present inextensible and overcrowded state.

The other project consists in providing a larger and more convenient Record Office; as conveniently situated; less liable from its situation to accident by fire or violence, and capable of extension to any size at a moderate expense. Indeed, if both projects stopped here, supposing the expense to be the same, I think many would decide in favor of the last; myself I have no doubt about it; but I can scarcely consider myself as an impartial witness.

Besides this, however, the second project doubles the library accommodation of the Museum, quadruples the accommodation of the reading-rooms, and admits of the ultimate extension of the library beyond anything that can at present be conceived to be necessary.

In the next place, the latter project also doubles at once the accommodation of the Natural History departments of the Museum, provides for their indefinite extension, and admits of their being classified in any mode, or according to any system that may be required.

In the fourth place, it doubles at once the accommodation at present available for the national collection of painting, sculpture, and antiquities, removes the two last to a more convenient situation, and admits of their ultimate extension to at least four times their present extent; besides giving them the advantage of all the improvements that may be suggested for lighting and arranging, which are so lamentably deficient in the repositories where they are now placed; and admits of the National Gallery being rebuilt without inconvenience, whenever it is thought expedient to do so.

Lastly, the expense of the two projects would be nearly the same, but most probably the least expenditure would be that required for the second; at all events, it certainly would be so as to time. For the first project, the whole money would be required in ten years at the utmost; for the second, the expenditure might be spread over fifty years; and indeed it would not, under any circumstances, be all required before the end of that time.

It remains for the public to determine which of these two projects it will adopt.

APPENDIX.

Appendix A.

Museum Library Catalogue.

It is almost impossible to write regarding the British Museum without reverting to the much mooted subject of the catalogue, and as one of the sufferers, I cannot refrain from entering my protest before it is quite too late against such a noble institution being made so nearly useless to satisfy the fancies of certain parties in power.

I am not, of course, going to enter here on the question of the deficiencies of the Library. As I have said in another place, it is nearly useless to me as it must be to every one who wishes to be "à la hauteur de son siècle," in either science or art; it is a noble museum of curiosities of literature, but it is conducted on principles of most sublime contempt for the utilitarian exigencies of modern times; and I cannot but consider it as somewhat unjust that as authors are the only class of her Majesty's subjects specially taxed in kind, that they should not in return have the privilege granted them, of obtaining by Government assistance, the last information on the various subjects of their researches. I must not, however, be tempted to digress on so sore a point; nor shall I enter upon the "vexata questio" of whether the catalogue should be a classed one, or merely alphabetically arranged; because I believe that if practically stated and considered, nine men out of ten, or perhaps rather ninety-nine in a hundred would vote for the latter. The truth being that an alphabetical catalogue is an absolute necessity to a public library. A classed one, on the other hand, is only a luxury; one, I am by no means inclined to under-rate, but I am convinced that no classed catalogue will ever suffice of itself, to ascertain whether a book is in the library or not; it must be considered as of secondary, while the other is, and has always been, considered of primary, imimportance.

I am convinced I am stating what is literally true when I assert that the formation of an alphabetical catalogue is the simplest and easiest operation in literature, and I am confirmed in this opinion by observing that there is not an auctioneer, or bookseller, or librarian in the three kingdoms who cannot make one, and one that answers all purposes for which it was intended—which is simply to know whether or not a certain work is in the library in question—which is the only purpose an alphabetical catalogue can answer. So far as my little experience goes, I do not recollect a single instance in which I could not ascertain the fact, and if any one will take up the catalogues of a library for sale, or any bookseller's list of his works, or that of any public or circulating library, or such a catalogue as Brunets, the probability is that in 999 instances in 1,000, he will find the book he wants on a first reference, if it is there. On a second reference he ought not to fail once in 10,000 times; and I am mistaken if in five minutes' search, he may not satisfy himself certainly as to whether the book in question is in the library or not.

Now this is not the case with the Museum catalogue. An immense class of works is entered there under titles by which nobody knows them, and under which they never were entered in any other catalogue. To take one instance as an illustration. In the new catalogue the works of Voltaire are entered under the name of Arouet. I happen to know that this was his father's name—but ask any bookseller if he has a copy of such an author's works or any gentleman if he had ever read them, I feel certain they would answer with me that they never heard of such an author; and I am perfectly convinced that on opening any other catalogue in the world and not finding Voltaire's name in it, I should have arrived at the conclusion that his works were not in the library. It never would have occurred to me to look under his father's name.

Once, however, the rule is known a man may, by a little industry, and reading up, generally get at the book he wants; but there is another class where this is not so easy. The Museum, for instance, acknowledges no man that writes with his pencil; unless his ideas are conveyed in words he is nobody; every one for instance knows Roberts's "Syria," but unless he can have access to the work before he goes to the Museum, no wisdom will tell him to look for it under the name of Croly, or for the same artist's "Egypt," under the head of Brockedon. If a man reads Dennis's "Etruria" he will see Byers' "Tarquinian Sepulchres" quoted twenty times over, but "Dennis" will not give him a hint that the name of the book in the catalogue is "Howard," nor when he sees mention made in the same work of Stewart's "Phrygian Remains," will he tell him that it is entered under a name where neither reader nor librarian can trace it, though one copy I have seen in the antiquity department, and I believe there is no doubt but there is a second hiding itself in the library. One, perhaps, of the most amusing entries I have come across, and one certainly utterly beyond my power of guessing, is the "Museo Gregorio," one of the best known, and most valuable works in Etruscan antiquities. In it the catalogue figures under the title of "Maximis," because it is dedicated to Prince Massimi, in Latin; and this being the only text in the work, according to the rules, this is the title.

I could go on multiplying examples of this sort to any extent. The above will suffice to illustrate the absurdity of a rule which renders a most valuable portion of the library inaccessible to the public. At one time I believed that it was intended for the purpose of preventing the *profanum vulgus* from thumbing so valuable a class of works. I am assured this is not the case, but the effect is the same, for unless the reader has access to the works before he goes to the Museum, he will not be able to find one of this class in the catalogue. Another equally absurd rule is that when the work is anonymous, it shall be entered under the *first substantive* of the title. It ought, of course to be the *principal substantive*. Thus a History of Ireland, or any other country is entered among some thousands of Histories, through which the reader must wade to find the one he wants; while, if it should turn out to be an "abridgment" of the History, &c., he must wade through all the abridgments in the library. If it should happen to be a "Summary of the History," or have any other subtypical affix, he must go through every conceivable variation before he is sure whether or not the work he wishes to refer to is in the library or not. If it was entered "Ireland, Histories of, &c.,—Anonymous," nothing of the class could be so numerous, but that the search would be easy, and the result at all events would be certain.

Or to take another instance, supposing in reading some book I am referred to a curious account of the life of Prince Arthur and the Knights of the Round Table, printed by Caxton, in 1485. If this were entered under "Arthur, Prince," there would be no difficulty. But unless a man sees the book, he may guess through his life before he finds it in the catalogue. The book in question has two titles, "Morte d'Arthur," is the popular one. The true one being "The Byrth, Lyf, and Actes," &c. Even if told it is the "Birth, Life and Acts," he must not look under Bi. To whom would it occur to look under By? If Lyf happened to be the first substantive, it would require a new search; and if Acts, a third before there was any chance of finding the work in question.

But what is the use of multiplying particular instances? No alphabetical catalogue ever requires any rule to make it intelligible, and every one can find in it the work he wants. It requires that the reader should remember ninety-one very long and puzzling rules before he can ever hope to find a book in the Museum catalogue, and even then he will not succeed in many cases unless he has access to the work itself before he goes to consult the catalogue.

Is this as it should be? The experience of centuries has taught all the world how to make and how to use alphabetical catalogues. The trustees have rejected all this knowledge and all this experience, to indulge one man in a favourite whim, and that man is one who whatever his talents and abilities may be, has not yet given the world any proof that he possesses such transcendent abilities that the experience of all the world should be set aside for his sake, and that we must all go to school again to relearn our lesson according to his system. I myself would not personally object to this last condition, and would submit to any inconvenience to possess a catalogue, however absurd it might be; but the bulk of the readers will not do this, and after the delay of years and an expenditure of immense sums of money, the whole thing must be begun again, and the catalogue reconstructed according to the dictates of common sense.

Regarding this point, I am convinced, that when fairly stated, there can be no difference of opinion. There is however, another, regarding which I feel very clear, though I do not expect all to agree with me in it, which is, that the catalogue in the reading-rooms should be wholly in manuscript. If the library were complete, or if any branch of it were so, it certainly would be much easier to refer to it in print, than in even the very best handwriting; but in a growing library, I do not know any thing much more puzzling than reading first the printed part, then referring back two or three pages for the written titles, and then forward as far, for those that may come after the printing; and even then, you are scarcely ever sure that you have exhausted all the titles you should refer to. I feel convinced that the catalogue ought either to be wholly in print, or wholly in manuscript; and as the former is, I hope, utterly impossible for many a long day, there is nothing for it but the latter. When a manuscript catalogue is complete, it may, of course, be printed—indeed should be so—for sale and circulation among the public. It would be a most useful work, and one most worthy of Government patronage; but I am convinced, that for the reading-room, the only really useful one, would be the one in manuscript, always kept well written up.

APPENDIX B.

Classed Catalogue.

Besides the alphabetical catalogue, which I look on as the first requisite for the library being made available to the public, it would be the greatest possible boon to the readers, if they could be furnished with a good classed catalogue also; and it does not appear to me that there is any mystery about the subject, as many have asserted, or any difficulty that ought to impede its being granted to the public. If done, however, it must not be intrusted to those who have made such a mess of the alphabetical one; for whatever may be said on the subject, it certainly is more difficult to make a good classed catalogue, than a good alphabetical one; and the public will do well to wait till their voice, and that of common sense, can be heard, before they ask for what they must afterwards reject and reconstruct.

The mode in which I would set about making a classed catalogue is sufficiently simple. The only two postulates absolutely requisite being, in the first place, that the alphabetical catalogue be written up; and secondly, that the person employed to make the classification of the books on any subject, be moderately well acquainted with the bibliography of the subject he is employed upon.

To take an instance as the clearest way of explaining my meaning, suppose a man so qualified were employed to make a classed catalogue of the works on Architecture, all he would have to do would be to go through the catalogue from A to Z, marking in pencil every work on the subject he found in it; he would require an assistant to follow him, and copy out on slips of paper the titles he had marked, or to cut them out if they were printed. Once he had got all the titles he required, he must adopt some such classification as the following. General Treatises, Dictionaries, Philosophical Theories,—General Histories,—Didactic or Elementary Treatises,—Special Treatises, Ancient Architecture, Mediæval Architecture, and Modern Architecture; subdividing them according to nations, such as Egyptian, Grecian, Roman;—French, German, English, Italian, or Spanish, Gothic;—Arabian, Egyptian, Syrian, Persian, Indian, or Spanish Saracenic, and so on. These including, of course, special monographies of buildings, belonging to each of these styles. Special treatises on special departments of Architecture, civic, rural, marine,—or ecclesiastical, municipal, domestic, &c.

And lastly, treatises on the special Arts, such as masonry, carpentry, iron work, &c., and such arts as are specially employed in building, and, on the other hand, sculpture and painting, in as far as they are specially employed in this art.

Supposing some such scheme be determined upon, he must arrange his titles in heaps, under their heads, as he would sort a pack of cards into suits; and however perfect his first scheme may be, he will find a residuum which will not fit any one; he must then either interpolate new headings for them, or alter the old ones, so as to admit them into the old scheme; but with the knowledge of the books and their titles he will have acquired, this will not be difficult, and every work will eventually find its place.

The next operation is to paste these titles into a blank book, and the last to write them out fair into another for use.

The volume is then bound up and placed on the shelf, and, so far, the classed catalogue is complete. It is true the natural historian, the littérateurs, and all other classes of students, might fairly complain of the undue and unjust preference shown to the architects. But whatever was done eventually with this subject, this volume is a "fait accompli," requiring neither alteration nor addition, to fit it in with the rest.

The same process may be applied to every art and every science. Astronomy may be taken up next; or Zoology, or English or German literature, whichever is thought most needed, or for which the best man is at the moment available, or ten, or twenty, or fifty men—if the catalogue consists of as many volumes—may be employed on as many subjects at the same time, without the least interfering with one another, or caring in the smallest degree, about what his neighbour is doing. The catalogue of each department must be considered as a separate work, and each cataloguer must consider that he only is employed to produce a monography of the works in his own special department. Each, of course, will require a separate and distinct mode of arrangement, and some will be better arranged, no doubt, than others. A little general supervision would, however, easily correct this fault, and after all it is of the least possible consequence.

Supposing now that fifty or one hundred subjects were classified in this manner, and bound into separate volumes—how are they to be arranged? This I consider of so very little importance, that I would leave it to a sub-librarian, or to chance; or if I gave an opinion, I should say, arrange them alphabetically. It is true that, according to this, Zoology for instance would be about the last volume, Botany among the first, and Mineralogy half-way between the two, and many arts ands ciences come most unscientifically mixed up with them.

If the catalogue were meant to be a classified digest of human knowledge, all this would be very bad, and ought no doubt to be avoided; but a catalogue of books never was this, and what is more, never will be; nor will it even assist in forming this. All it can do, or pretend to, is to enable a student to ascertain easily and correctly what books the library possesses, treating of any particular subject. If it pretends to anything beyond this, it must fail. If, however, this is all it professes to do, it will be seen at once how unimportant the arrangement of the volumes must be. All I would stipulate for, is, that each volume should have its subject clearly lettered on the back, and that a printed list of the volumes and their subjects should be pasted in the beginning of each, and on a card to which every reader could refer. This done, every student could ascertain, in less than thirty seconds, which volume contained the subject he was looking for; and no scientific scheme, however perfect, could ever do more, if so much.

In speaking thus disparagingly of a scientific classification, I beg it may not be understood that I either despise such a thing, or think it unattainable. On the contrary, I look on it as the most important task allotted to men of genius and research in the present day, and I hope the sketch of such a classification, which I have given in the introduction to my work on the True Principles of Beauty, will suffice to show that I am neither ignorant on the subject, nor unmindful of its importance, and that I do believe in the possibility of its successful accomplishment.

Indeed, if it were worth while, I believe I could furnish such a scheme for the catalogue of the British Museum as would enable me to classify every work within its walls. But supposing this done, there is no one but myself who could reduce my scheme to practice, and no one could assist me but persons who were thoroughly imbued not only with the form but also with the spirit of my scheme; and lastly, it would be of little use, except to those who in like manner had thoroughly mastered it in all its details.

Another inconvenience would be, that if the projector of such a scheme died, or left it alone before it was complete, no one could complete it as it was designed, and the moment improvements and changes were tolerated, it would become confusion worse confounded; but even supposing he did live to complete it, time, and the improvement of science, and scientific knowledge, would before long so alter any such scheme, that it would soon become useless, and improvement would be impossible, without re-writing the whole. Or if these objections did not suffice, there is still another; for supposing the classed catalogue to be completed on a perfect scheme of human knowledge, perfectly carried out in every detail, it would not be so convenient, *as a library catalogue*, as the one I have been describing above. The first is not only possible, but of easy attainment, while the latter, I have no hesitation in saying, is impossible, not only from the present imperfect state of human knowledge, but because a sufficient staff of sufficiently scientific men could not be obtained for the purpose in any country of Europe.

APPENDIX C.

As a Parliamentary Committee is conducting an investigation into the best means of extending the advantages of public libraries to the provinces, I may take the opportunity of stating a suggestion more clearly than I should perhaps be able to do *vivâ voce* in evidence, as it appears to me to meet most of the practical difficulties of the question.

To make myself understood, I must request the reader to bear in mind that there are two classes of libraries; the first, such as the library of the British Museum, where no books are lent out to students on any pretence, but which, being wholly supported from imperial funds, is virtually the property of the nation, and to which every citizen has right of access, provided he can prove his competence to use it beneficially, and give the requisite guarantees that he will not abuse the public property.

The second class consists of such institutions as the London Library, purchased and supported wholly by private individuals out of their own funds, without any assistance from Government; the object being to supply the deficiency above noticed in the Museum library, by lending the books to the subscribers, which are thus in all cases consulted in the private residences of those using them.

What I would propose for the provincial capitals, would be, to combine these two kinds of libraries into one, in the following manner:—

In the first place, I would propose that no city should be allowed to apply for Government assistance, till they had provided a suitable receptacle for the library, when purchased.

To see how this may be done, we must revert to our Leeds mill plan. Each square of that building (36 feet × 36) costs less than 500*l.*, and will contain 15,000 to 20,000 volumes. It will, therefore, suffice, in the first place, to erect three, four, or five such squares, to be in the centre of the ground, to be eventually covered by the buildings. They would thus require no ornamental facing, and the whole amount of money required would be from 1,500*l.* to 2,500*l.*, a sum which I believe could easily be obtained by subscription in any of the first or second-class cities of the empire. At least I know that there is scarcely a parish in the kingdom where such a sum cannot be so raised to build or repair a church; and I cannot therefore doubt but that, if it is wanted, a like sum may be raised in a large city, for the edifice next in importance for the intellectual welfare of the people. I think Government should in all cases insist on this being done first, not only as an earnest of the intention of the community, and as a security for their advances, but also to save the library from the very heavy charge of rent, which sometimes presses most heavily on similar institutions*.

I include nothing in the above estimate for the purchase of a site.

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* It may be objected that my unfinished brick edifice, as above proposed will be very unsightly, which I admit. I provide, however, for ornament being applied whenever funds are available; but the first thing requisite for a library is books, the

as I believe there is no city in which one cannot be obtained free of expense, for such a purpose as this. The only condition requisite to be attended to, is that it shall be sufficiently extensive to admit of any conceivable extension at a future period.

Supposing this arranged, the next thing would be to get together a body of subscribers, exactly as has been done in the case of the London Library; say 6*l*. entrance, and 2*l*. annual subscription.

In the first year of its existence, that institution received 4,600*l*., and the average of the six subsequent years was about 2,000*l*. Of this money, rather more than 9,000*l*. has been spent in the purchase of 35,000 to 40,000 volumes of books; the remainder has been expended in rent, salaries, furniture, and other minor expenses incidental to such an establishment.

I do not suppose any provincial capital could equal this, though owing to the number of competing establishments, its want is less felt in the capital, than elsewhere. But supposing a town can raise half this sum; what I would propose would be, that Government should double whatever sum is so raised. For greater simplicity of accounts, and to prevent all possibility of jobbing, I would propose that the Government fund be always appropriated exclusively to the purchase of books, with such portion of the subscribers' funds, say one-third or one-half, as may be available, for this purpose. Supposing, therefore, that in the course of ten years Government were called upon to subscribe 10,000*l*. to the support of any particular library, 13,000*l*. to 15,000*l*. would be devoted to the purchase of books; and an excellent library might thus be got together of from 50,000 to 60,000 volumes.

This library I propose to consider in two lights: first, as a public library similar to the British Museum, furnished with an appropriate and convenient reading-room, to which all citizens have a right of access, without charge, subject merely to such restrictions as are necessary for the preservation of the property: and secondly, as a public library similar to the London Library, from which subscribers are allowed to borrow books and take them to their own dwellings, under regulations similar to those in force in the latter institution; with, of course, such modifications as local circumstances may seem to demand.

The latter privilege is of course an abstraction from the rights of the public, to a certain extent, but as it is paid for, I do not think it is one that can fairly be complained of. Besides that, in practice it is really of

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second a convenient, well-lighted, and ventilated fire-proof room to lodge them in; whatever is beyond this does not belong to the library, but to the committee of taste for the improvement of the town, with which at present I have nothing to do.

very little consequence, for judging from the experience of the London Library, it is not probable that so many as 1000 volumes will ever be taken out at the same time, from such an institution: and they will principally consist of novels and new works, of the class called light literature, which few would go to a library to consult. At all events, it is an objection which is equally applicable to the library of the British Museum, as no work is accessible to the public in that institution, till it has been at least five years on its shelves; and works of that age are almost as certainly to be found on the shelves of the London Library, as on those of the Museum.

There are, of course, many objections of detail that may be urged against this project, brought forward in so crude a way; but the real objection will be the expense, and the extreme unwillingness Government has always shown to grant money to support such institutions. Perhaps not without reason; for the temptation to jobbing is great, and at first sight it certainly looks like a local object that ought to be supported wholly from local resources.

These, however, I am convinced, will never suffice for this purpose: and it is needless to talk of introducing a higher class of education among the people, unless you provide them with the materials for improving and advancing themselves. But after all, what would the expense be? Supposing ten cities applied for aid, it would amount to 10,000*l.* per annum, or 100,000*l.*, in ten years, and this would suffice to provide ten libraries, averaging, say 50,000 to 60,000 volumes each. After they reached that extent, I would propose that the Government grant should be only one-third or one-fourth of the subscription; and after they reached 100,000, cease altogether; as that number I believe to be amply sufficient for all practical purposes of provincial libraries. Should such a sum deter us when we are spending a million of money to ornament the outside of our new Palace at Westminster? and have spent twice the sum on the outside ornament of the Museum; not to mention fifty other instances where money has been thrown away, and will be again, without any benefit to any one; while surely this is one of great national importance.

APPENDIX D.

As I have offered a suggestion regarding libraries, I may perhaps be allowed to bring forward one in this place, regarding Art-Unions, and the means by which they might be rendered available for the establishment of galleries of art, in the metropolis and provinces, as I conceive them to be almost necessary adjuncts to libraries, and certainly most important implements in advancing the cause of education.

In the present instance, if the buildings were erected as recommended in the last section, for libraries, one, or two, or more squares might be appropriated as picture galleries, and these might be added to, without interfering with the book department, as occasion required. If sculpture galleries were also wanted, all that would be necessary would be, that they should be placed to the extreme northward of the proposed buildings, and lighted somewhat differently from the rest.

The great point, however, is, how are the works of art, to fill these galleries, to be obtained?

Few great towns are without some works of art, which might be made available for this purpose; and private liberality would, I am convinced, do a good deal towards it. But neither of these will suffice, and I fear we must not, in this instance, ask Government to supply the requisite funds; at least, I do not see how a sufficient case could, at present, be made out, to justify the application of imperial funds to this purpose. Once the galleries are established, their importance acknowledged, and their influence felt on the schools of design, and other similar institutions, and when besides the mode in which they are to be maintained is better understood, Government may be asked to come forward in aid; at present the one mode that seems to me likely to answer, is by the assistance of Art-Unions, which I would propose to organize somewhat in the following manner.

Before, however, proceeding further, I wish it to be understood that I neither intend to find fault with the present Art-Union of London, nor do I wish it superseded by the one I am about to propose. It does not perform, it is true, a high function in the advancement of art in this country; nor, I believe, so high a function as Art-Unions might perform; but it has a distinct and well defined aim, one that I am convinced is most beneficial to the good cause, and one which I should be very sorry indeed, to see abandoned. It collects from 10,000*l.* to 20,000*l.* annually, from people, who, without its intervention, would probably not spend sixpence on objects of art, and distributes the money among that class of artists who stand most in need of it.

If it attempted to encourage high art, by purchasing the best pictures of the best painters, it appears to me it would fail entirely in its vocation. The best painters can take care of themselves, and want no assistance from such a society; but the young beginners, and those who are struggling forward to get themselves known, do require its aid, and practically it is this class who benefit by its awards. Besides this, it diffuses a great number of works of art among classes who neither could or would possess them without this means of obtaining them; and even if they are not of the highest class, they are at least higher than any other they possessed before; and may awaken a taste for better things, that otherwise might for ever have lain dormant.

To perform its true function, art cannot be too widely spread, nor too various in its forms; and what the very refined look down upon as vulgar and common-place, has sometimes as important a function to perform, as the more refined and poetic creations of a higher class of artists.

Leaving this society, therefore, to perform its functions, I wish to propose a second to perform another office in aiding the good cause, which the following sketch may perhaps render intelligible.

In the first place I assume that the new society can collect as large a sum as that collected by the old one, or to simplify the matter let us assume that they have collected 15,000*l.*, I would prefer this being done by tickets of 5*l.* in value each, but as those of 1*l.* are more common, I shall not insist on the former here.

2nd. The money being collected, I should propose to open an exhibition specially for the Society, to which all artists should be invited to send their pictures. In the first instance, at all events—whatever may be determined on afterwards—I would not ask whether they had been exhibited before or not, but would insist that they should be *bonâ fide* the property of the artists exhibiting.

3rd. To every picture a price should be affixed by the artist, which should be attached to the frame, or at all events printed in the catalogue, and no work should be admitted whose value was below 200*l.*, or certainly not under 100*l.*, a committee to have the power of rejection when this is manifestly the case.

4th. When the exhibition was opened I should propose that each subscriber should be invited to register his votes for such works as he thinks should be purchased for the society. I wouldgive each individual three votes for one ticket if he possessed only one, but to prevent any one having overwhelming influence, I would graduate the votes according to some such scale as this:—1 ticket = to 3 votes, 2 = to 5, 3 = to 7, 4 = to 9, 5 = to 10, 10 = to 15, 20 = to 20, and one vote only for every ticket any member possessed beyond 20. The subscriber being entitled to give all his votes for one work of art, or to distribute them as he pleases at his own discretion.

5th. Admission to the exhibition for non-subscribers to be one shilling, and I would request every visitor on leaving the gallery to register his vote for what he conceives to be the best work in the gallery, or rather for the one he thinks it most expedient the nation should purchase, taking into account not only the quality of the art displayed in it, but also the price.

6th. The money collected at the door to be kept separate, and called the public fund, as contradistinguished from the subscribers' fund. It is of course impossible to foresee what it may amount to; but as the Royal Academy collect some 6,000*l.* or 7,000*l.* in this manner annually, and I see no reason why this exhibition should not be as popular as theirs; let us assume it at 5,000*l.*

7th. The expenses of the exhibition to be debited to the two funds in some ratio to be determined on, say half to each, or in the ratio of their respective amounts, or some such proportion.

8th. When the exhibition is closed and the number of votes of each class ascertained, the list to be published, and those pictures having most votes declared the property of the society. In ascertaining this I would propose that three public votes be considered equal to one subscriber's vote, or two, or one as may be determined on; perhaps, two would be the best ratio, thus giving a non-subscriber one-sixth of the influence possessed by a subscriber.

9. In the next place let us suppose that the net amount at the credit of the public fund to be 4,000*l.*, and that the first six or seven works at the top of the list—say six pictures, and one statue—cost that amount, they become at once the property of the nation or of the city where the Art-Union is held, and are transferred at once to the public gallery. If the net amount at the credit of the subscribers' fund be 14,000*l.*, as many works next in rank in the list as this will purchase become the property of the subscribers, to be raffled for among them in any manner that may be determined upon. I do not think the subscribers have any reason to complain of this mode; as the whole of their money barring a portion of the necessary expenses, is employed in the purchase of works in which they are interested, and though it is true the best works go to the nation, I am convinced that an Art-Union of this kind would call forth a higher class of works than now exist, and that the tenth or twentieth on such a list would be a better work of art than can now be purchased at any price.

10th. In the first instance I would propose that the metropolitan competition be triennual in the three capitals of London, Edinburgh, and Dublin, and that the provincial ones also recur according to some established routine in the principal cities. I do not think that even London could support such an institution annually.

Besides, however, the advantages to be obtained by such an institution in forming galleries of British art, selected according to the best and most unexceptionable principles, I conceive that such a competition would have a most beneficial effect on the artists themselves, inasmuch as they would then have a tribunal to judge of the works, from which there could be no appeal. For though a few individuals might vote for a work, not because they admired it, but from their personal feelings towards the artist, I would not object to this, as I think every man is entitled to the advantage of the friendships he can form, where there is sufficient to counteract its becoming a job or the voice of a clique. In this instance it is utterly impossible that anything but superior merit could influence some 50,000 votes, given by persons all of whom have an interest more or less direct in the property their vote goes to acquire.

To the artist himself the hightest prize his profession can afford must be, to be the first, or even to stand high on such a list. The most satisfactory testimonial would be his selling his picture at his own price, and the most enduring memorial of his triumph must be his work being transferred to the walls of a national institution under such honourable circumstances. If such prizes, so awarded, will not encourage a better and higher class of art than now exists, I for one should be inclined to despair.

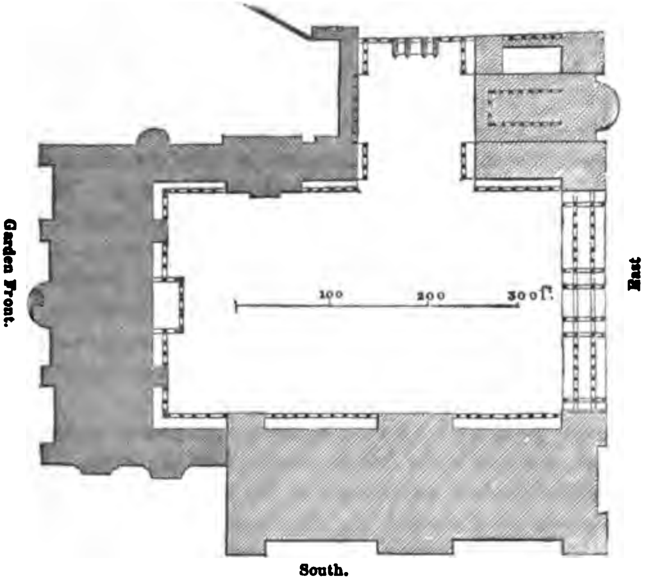
Another advantage would be that by this mode the public taste would be improved, and they would acquire a habit of judging of the relative value of works of art, which it is extremely difficult to give them without proposing an object. In the present instance I am convinced that a great body, not only of the subscribers but of the public, would go back and back again to the exhibition and carefully scrutinize and weigh the merits of every work of art, before they registered their vote for any one, and even then the most careless and indifferent must think more of the subject than probably he ever did before, when called on to select one which he thought the best of the whole.

APPENDIX E.

As I said in the text, that I never found fault without satisfying myself I could do better, and generally tried to give the public an opportunity of judging whether or not I was correct in the assumption, I may as well state here briefly, how I would have proposed to add to Buckingham Palace, as I have stated that I disapprove *in toto* of the mode which has been adopted for the purpose.

The annexed wood-cut is a reduction of such part as is necessary for my present purpose, of some larger plans which I sketched out with elevations and sections, when the proposed alterations were first talked of. The part shaded darkly, represents the existing building; the part shaded more lightly, the addition I proposed should be made. It will be observed from it, that the old building is left almost exactly as it is, and only about one-half the southern wing removed, and replaced by a block of buildings, 400 feet in length, by 150 in width.

This I proposed to make five honest stories in height, so that its cornice should certainly not be less than one hundred feet from the ground-floor line.



The Corinthian order, with its entablature, I proposed should be continued round the new building, where requisite, but as it would have had two stories and forty feet of wall over it, it would have been reduced to the position of a mere secondary and subordinate decoration, as the whole building would have been surmounted by a bold cornicione crowning the whole. The roof and chimnies of the building would have been shown, and perhaps angle or central towers used, so that the height of the whole edifice should not have been less than say 125 feet to 140 feet, or about twice the height of the original edifice.

Such a mass of building facing Piccadilly would have gone far to redeem the defects of the situation of the building, by making it a really imposing edifice, from every point of view; and would, besides, have hid entirely the dingy neighbourhood in its rear, which at present offends so painfully, when seen in juxtaposition with the Palace.

The defect in the arrangement that will occur to every architect, is its irregularity, or the lop-sidedness of the design. This, however, I am convinced, is not a just objection, for the motive of the whole is at once apparent. The new building, situated in the piazza, is the public, or state palace; in the other, or old buildings, are the private apartments of the sovereign, situated in the gardens. By this arrangement, too, the comparative insignificance and prettiness of the old buildings would become appropriate, as suited to the private, as contra-distinguished from the state apartments of the Palace.

The real front of the new, as of the old building, however, would have been turned towards the east; and to balance the new wing on the north side, I proposed in the vacant corner to erect the Palace-chapel, with the dimensions of a church—one of the most indispensable and appropriate ornaments of all ancient palatial erections, and one, the want of which is powerfully felt in all modern ones. The central dome and belfry-towers of the church would have been at least as high, or higher, than the new wing; but, from their want of solidity, they would not have interfered with its massiveness, but on the contrary, have aided it by contrast, and balanced the whole composition. Around the church, it was proposed to group the ecclesiastical residences, guard-rooms, and other offices necessary to a palace, but not properly an integral part of the edifice itself.

The marble arch, with a few alterations, I proposed re-erecting on the northern entrance to the Palace, as shown on the plan.

Among other obvious advantages of the arrangement, would have been the power of extending the buildings to the eastward to any desired extent, without either pulling down or altering the existing edifices.

It is of course not necessary, in such an *ex post facto* design, to attempt to explain the arrangement of the state apartments, or of the details. I believe I have said enough to enable the public to judge whether the mode adopted for altering the Palace is or is not better than the one here proposed.

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METROPOLITAN

WATER SUPPLY,

Present and Future;

IN FOUR LETTERS
TO THE
"DAILY NEWS" NEWSPAPER.

BY JOHN LOUDE TABBERNER.

London:
HENRY RENSHAW, No. 356, STRAND.

1850.

PRINTED BY T. BRETTELL, RUPERT STREET, HAYMARKET.

With the Author's respectful compliments.]

# METROPOLITAN
# WATER SUPPLY,
Present and Future;

IN

FOUR LETTERS TO THE "DAILY-NEWS" NEWSPAPER.

I. *Showing that Water is not a commercial property, and ought not to be subjected to commercial control. That the Metropolitan supply should be a public institution, administered by a public commission, possessing powers under an Act of Parliament, as suggested.*

II. *Showing the present monied position of the existing companies; the cost of their present supply to the public; the value of their present plants and the value of all existing interests in the present Water Supply; with an explanation how the whole may be fairly purchased and paid for by the public; and how an improved supply may be obtained, and the whole Metropolitan Water service permanently secured as public property, without requiring any advance of money, either from the Government or the Rate-payers, and without increasing the present average rate per house.*

III. *Showing the quantity of Water as at present supplied to the inhabitants from all sources; and the various means available for affording an improved continuous service to every room in every house throughout the Metropolis; at the same time establishing an abundant supply for all sanitary purposes.*

IV. *Showing the qualities of the chalk and river Thames Water respectively; and explaining why the water of the chalk formation, beneath and around London, differs in its constituents in different places.*

BY JOHN LOUDE TABBERNER.

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PREFACE.

TO THE LONDON PUBLIC.

The series of Letters I now respectfully submit for general perusal, were recently written to the *Daily News* newspaper, and were called forth by the current events pertaining to the question of an improved supply of water to the Metropolis. They advocate the principle of public control I have long striven to establish over the distribution of water to the inhabitants of London, and which I am emboldened to believe is universally approved.

Without that egotistical presumption some are always forward to attribute to faithful and confident enunciations, I beg to say that if the principles upon which I have based the suggestions I have ventured briefly to offer should be authoritively acted upon, a lasting and growing vitality will be imparted to the physical strength of the people, which will invigorate and improve the social condition of society, and elevate the moral worth of all; for I hold it as a *truth* which cannot be too deeply impressed upon the mind of every individual, especially upon the wealthier classes, that only in proportion to the efforts made to stay the moral degradation of the suffering multitude, by affording means to make their homes habitable and domestic comforts attainable, whereby their physical powers may be improved, will industrial energy strengthen and thrive, vice and crime appreciably cease, pauperism and sickness diminish, parochial and national burthens decrease, and the respective grades of society continue to be acknowledged and respected. Example is a first incentive to moral reformation; and until the parent is physically stimulated and morally reformed, to an active sense that it is his first natural duty to nurture his offspring in virtuous and honest habits, no sound moral or intellectual progress will be manifest amongst the lower orders. The root and the stem must be made healthy before the branches will blossom or bear fruit; or where, from irretrievable decay, the former accomplishment is rendered impossible, the latter must be entirely lopped from the parent trunk, and, in the absence of natural support and protection, must be afforded comprehensive and enlightened public succour.

That the means of cleanliness—AN UNINTERMITTENT SUPPLY OF WATER, *the first element of physical improvement, and the strongest bulwark against disease*—is the very fulcrum of all sanitary ameliorations must be, and is, universally admitted; and as such, therefore, it should be a subject of the first consideration in contemplating effective and substantial sanitary improvements.

I have not, in the annexed Letters, adverted to other questions necessary to be considered in perfecting an efficient sanitary code; but my conviction is, that the drainage and sewerage, paving and lighting, and the erection of metropolitan buildings, should be under the administrative powers of the same commission as the water supply—at least, if not under one and the same commission, they should respectively be under the control of such responsibly constituted commissions as I have suggested to administer the water service.

I would be distinctly understood, in making these few remarks, as supporting literal local government *over all institutions* requiring for their support and conduct *direct local rates;* for I contend that as the inhabitants pay for all such administrations, they are entitled to have a direct voice in the expenditure thereof; and if the control of such expenditure be solely vested in an irresponsible power to the *rate-payers themselves*, I further contend that in such an instituted power is perpetrated an unconstitutional infraction of the civil privileges of the public. I am aware the received supposition is, that *no* irresponsible power can exist under our constitution,—that *through* parliament *all* commissions appointed by the government are made responsible to the people,—and in such sense, in fact, is the political acceptance of such commissions; but, literally speaking, and indeed in a practical sense, commissions so appointed by the government to administer *local affairs* are *irresponsible* to those directly and immediately affected by their acts. So *indirect*, so *remote*, is the responsibility of such commissions to the rate-payers *that it is not only understood as a matter of course to be, but really is, merely nominal.*

I also earnestly maintain that it has been, and, while England is naturally great within herself, ever will be, through our local institutions that the constitution of our common country derives its civil strength and political power: to destroy, impair, or circumscribe those local institutions, or the principles upon which they are founded, would be taking away the internal pillars which support the structure of the constitution, leaving only the bare external portions of the fabric, first to totter, and then to fall.

But while I seriously and sedulously advocate local government as a civil right, and as an invulnerable safeguard to our international prosperity and peace, I am not insensible to the growing abuses it is subjected to, as the wealth of the general community augments, and as the population and civil responsibilities of each municipality increases; and as these respective developments of civilisation naturally enlarge, it is essential, having due regard to a fair representation of all interests, to centralise the local administration of all large cities within one, or as few common scopes of action as possible, so as to secure economy, uniformity, and efficiency in all municipal operations. And I further submit, that just in proportion as it is essential to have a check upon the Government's expenditure of the public revenue through the Commons' House of Parliament, so it is expedient to have a check upon local administrations to preclude the possibility of abuses, through a counter responsibility;—such or similar to that indicated in the following correspondence.

I am faithfully yours,

JOHN LOUDE TABBERNER.

6, *Essex Street, Strand,*
London, March 30th, 1850.

WATER SUPPLY TO THE METROPOLIS.

TO THE EDITOR OF THE "DAILY NEWS."

SIR,

Believing your valuable columns are always open for the promotion of any important public good, and knowing the subject upon which I am about to offer some remarks and suggestions to be of importance, and believing that my observations will do no harm, but may do some good, and not prove altogether uninteresting, I beg respectfully to ask the favour of your affording them insertion in your paper.

It is very probable I should not now have been induced to trouble you, but for the extensive circulation of an anonymous handbill, headed " Water Supply of London, and Government Centralisation and Parochial Management *versus* Competition by Private Enterprise," to which my attention has been directed, and which has evidently been published, if not directly, indirectly, by the London (Watford) Spring Water Company, lauding the Watford scheme, reprobating other schemes before the public, and denouncing the proposition to place the control of the general water supply under a public commission, responsible to the inhabitants, and in which allusion is also made to myself.

The London (Watford) Spring Water Company are using every effort to find a nook in the public mind for the sanction of another water monopoly, in addition to those we already have, for some generations past, been struggling under; and with all that professed disinterestedness and transcendant ebulliency which so pre-eminently characterised some of the existing companies when they first sought to raise their heads to chartered authority and dignity, the promoters of this Watford project are, by the use of the most complacent professions and specious promises to the public, strenuously endeavouring to establish their wily hopes in the formation of a new company, under the same exclusive and oppressive principles as the companies now in existence possess, in direct violation of the first and most important domestic interests of the London community. It is with the view, therefore, of once more urging public attention to the form of control which any new scheme or measure may seek to assume over the water supply that I am induced to address you. The sole point in the great question of reforming the water service of the metropolis, which the public should and must be critically jealous upon, is that of control. As far as an improved supply of water extends no apprehension need exist, for we have a superabundance available to our wants. The difficult part of the question, and that which must be attended to by the public is, what administrative power shall be established over the water service for the future?

The Watford scheme I object to for more reasons than one, but more particularly because its promoters have brought it forward under the auspices of a trading company; but why I entertain other objections to the scheme will be seen in the course of my observations.

I know many are opposed to me in the views I have formed as to water not being a commercial, but on the other hand being a public property, and hold the diametrically opposite opinion, *viz.*: that it ought to be supplied to the public by trading bodies, under what they denominate the wholesome and equitable influence of commercial competition. In my past advocacy of the views I entertain, all motives, excepting fair and just ones, have been attributed to me by my adversaries. They say that I am about to establish an eight-headed monopoly, a long-armed centralisation, a jobbing government control, and an irresponsible commission, and many other equally absurd and misnomered intentions they charge me with, and also those who hold similar views to myself; notwithstanding I stand by the views I published in 1847, and no one opponent has yet successfully advanced one reasonable argument against them. I then contended, as I now do, that water is a first element of life, and as such should be, with light and air, municipally considered and provided in all densely populated communities. These three elements of life are first attributes of man's subsistence, without which it is impossible he can live. They are primary components which, in the incomprehensible wisdom of God, are ordained as means of vital power in sustaining animal and vegetable life, and to such benificent ends they should be duly, abundantly, and freely applied; and not made the means of a sordid, commercial, and national tribute, to the circumscription, indeed to the destruction of the poor man's domestic comforts and health, and consequently his moral and industrial usefulness. I am aware, at this point of my argument, it will be contended that I might with just the same amount of reason on my side, say that bread, and all articles of food upon which man subsists should be considered and treated as public, and not as commercial property. Here I ask to be distinctly understood, for it is here the gist and value of my assumption, and also that of my opponents, must be tested. The absolute production of air, light, and water, does not require the labour, skill, and care of man. They are, as I have before said, first attributes of man's subsistence, and stand alone as the production of divine arrangements for the sustenance of animal and vegetable vitality. On the contrary, all other necessaries for man's subsistence requires his own labour and skill to produce them, and as his labour and skill are his natural means whereby he is enabled to provide for all his natural and artificial requirements, and as the amount and quality of both the labour and skill of every individual vary, one producing more and another less, all articles, whether of food or otherwise, first dependent upon that labour and skill, should, under such commercial codes as should neither stultify the vigour nor destroy the buoyancy of industry, nor oppress social or political freedom, be subjected to that wholesome competition which legitimate demand and supply alone ought to regulate; consequently, I contend that it is the duty of all governments to provide such social arrangements as shall afford to man in due amount those first elements of subsistence,—air, light, and water—for the support of his life and health; and, on the other hand to provide such equitable national and commercial laws as shall best create and protect a mode and market of exchange for the disposition of all those surplus products which accrue beyond the first and natural wants of man, from the industrial application of his life and health. I therefore affirm, that water is not a commercial property, and ought not to be made a commodity of sale; and where, as in all large towns and cities it is essential to subject its distribution to municipal regulations, it ought to be afforded to the inhabitants as public property, at the bare cost of conveyance; and I again repeat, that it is a first duty of a government to enact such laws as will provide such municipal regulations.

Prior to the year 1580, the water supply of the metropolis was ever considered of paramount importance to the health and comfort of the inhabitants, and was placed under the management of the public authorities, whose duty it was to provide such means as would afford an unlimited supply of water to rich and poor alike—not as a commercial but as a public property; and it has been a culpable oversight on the part of our legislature, amounting to a positive abrogation of an inalienable, indefeasible natural right, in subjecting, in the first instance, the distribution of water to the people, to commercial caprice; and, in the second instance, to an oppressive, exclusive monied monopoly, against the greatest knavery of which no power of appeal, no means of redress is afforded the public; and I have said again and again, and now repeat my unalterable conviction, that to grant any fresh powers whatever to the present, or to any new companies, would be enlarging gross legislative errors, and extending the field of a disgraceful monopoly, and strengthening a power directly opposed to social progress. And however sanguine of success the Watford Company or any other water company may be, as to obtaining further powers from parliament to construct new works under their own exclusive domination, I do sincerely hope, as I believe, they will not succeed.

I will now just take a pounds, shilling, and pence view of the question, and I think I can, from deductions under that head alone, also prove that water is not a commercial property. The history of the existing water companies has of late been so frequently afforded by different parties, that I need not now allude to it beyond what is absolutely essential to substantiate my position. It will be remembered that up to the formation of the East London Company little or no competition existed between the old water companies, excepting now and then a little spirit of antagonism might have exhibited itself; up to that time their days were palmy and their gains golden. It was only after the establishment of the East London, Vauxhall, West Middlesex, and the Grand Junction Companies, that competition in the distribution of water had a fair trial. It commenced in earnest in 1810, and lasted till 1820. During that time two or three companies laid their respective pipes through the same streets, and as time passed on they in many parts in the spirit of opposition to, or I will rather say of "competition by private enterprise" with each other, they offered their water to some for a very small charge, and to others even without any charge, in order to obtain customers; but what did it all end in? They discovered at last that the commodity they were supplying to the inhabitants cost each company about the same—most of it being from one and the same source of supply—and that the working expenses of distribution were about the same to each; and that so long as they went on opposing each other, while one possessed no practical advantage over another, they could gain nothing for themselves, consequently that the capital they had invested in these at first supposed lucrative undertakings made no profitable returns under the principles of commercial competition; they, therefore, determined that the commodity they had to dispose of to the public could not be produced as a commercial property, and, consequently, could not be subjected to legitimate commercial regulations; in fact, that it would not bear competition. The very serious consequence of all this to the inhabitants will be manifest. Under the influence of "competition by private "enterprise," several sets of pipes had been laid through the same streets, the expense of engine power and working contingencies multiplied accordingly; and the very significant question which now arose was, how was the capital which had been so recklessly invested, under wrong principles, in constructing two or three plants, where one, under proper municipal regulations, would have answered all purposes, to be made to pay a dividend to the shareholders? I think at this moment of the reign of our most gracious sovereign the Queen, I need not attempt to show how this very important question was at that time answered by the shareholders of the companies. The inhabitants have, indeed, been very impressively taught how the then very difficult problem was solved. It is too well known that in many parts two or three sets of pipes have ever since been lying underground perfectly useless, while the inhabitants have been called upon and made to pay dividends upon the investment. I doubt not but every householder in London is by this time grievously acquainted with the fact that, when the water companies found themselves in a state approaching bankruptcy and ruin under the operation of commercial competition in the disposition of a commodity which, they at length discovered, was not a legitimate article of commercial enterprise, the only alternative left to them was to establish an exclusive district of the metropolis and a monopoly to each, capitalise all their respective outlays, and levy such a rate upon the inhabitants as would enable them to reimburse all the losses they had sustained in "competition by private "enterprise;" and to declare a dividend for the future upon all the capital they had so uselessly invested, thereby increasing the price of water to each householder three and fourfold above a fair and just charge; and in reality making the public pay ten years' arrears of profits to each of three or four companies, and ever since any amount of rates they respectively choose to exact. It is well known that, since this exclusive arrangement among the companies was effected, the water rates in no instance have been once reduced; on the other hand, they have been uniformly increased, till both the oppression and the charges have become intolerable. It is also well known that the public has no voice or redress against any further increase of charge or any abuse of power these monopolists may choose to inflict upon it.

Thus have the inhabitants been virtually tied, hand and foot, ever since 1820, while the companies, under the security and protection of powers obtained, based and granted on wrong principles, have taken out of their pockets any amount of money they have thought proper to help themselves to, till they have well stored the purses their competition against each other emptied; and, at the same time, made the inhabitants pay for all subsequent extensions of their respective works, the outlay of which they have also capitalised, in addition to all former outlays, whether in the construction of works long since worn out or otherwise, upon the whole of which they now make the helpless public pay comfortable dividends and bonuses to their respective shareholders. All this has been, and is, the inevitable result of short-sighted legislation, and of the companies, in their covetous cupidity, discovering that water could not be dealt with as a commercial commodity; and that it could only be made to pay commercial profits, and usurious gains, under the exclusive administrative powers of one of the most infamous monopolies history has to record. Infamous, I repeat, for it is to that exclusive combination of individual aggrandisement, the fearful, I will add awful, amount of physical, and consequently moral, degradation, which abounds in, and taints every alley and street of the metropolis, is to be in a very great measure attributed, and which has tended more than anything again to progressively increase, with the growth of population, the intemperance, improvidence, and misery of the lower classes; the intellectual elevation of whom it will be worse than folly to attempt, till their physical comforts are better municipally cared and provided for.

The above are my grounds for opposing the establishment of any new Water Company, or extending any new powers to the present Companies; and indeed the substance of my reasons for urging the entire abolition of all the latter, and for endeavouring to establish the general water supply as a public institution on a self-supporting principle, under the control and management of a public elective commission; and I will beg briefly to state what my suggestions are in reference to improving the water supply, and the administrative powers necessary to be established; and to show the fiscal benefits which will accrue to the public by an enlightened administration of such a public institution.

In thus enunciating my views necessary brevity must preclude my enlarging on the general question; I shall therefore merely say that I would make the water service to every house and building, of whatever description, a part of the ground freehold, for this simple reason. No man would think of building any house without he could obtain water thereto; ergo, no site can be eligible for building purposes without a supply of water:— If a man therefore possesses building property or purchases a site of land on which he purposes building, I would compel him to have and pay for a water supply to it; and I contend it is owing to the absence of a regulation of this kind in the construction of our towns and cities, that the greater portion of our present sanitary evils and difficulties have arisen. I would deal fairly and justly with the existing Companies: I would purchase all their plants, and apply the same to sanitary purposes. And I would establish a new continuous service throughout the metropolis for domestic purposes. All this I would do, and I will show how it may be done, without asking government or the inhabitants for one shilling; while at the same time I will show that the average rates, as now charged by the present companies, would not be increased one fraction, but considerably reduced.

The practical way to set about accomplishing my suggestions is this. The government should either introduce or support a measure through parliament for affording an improved supply of water to the metropolis. Such a measure should—1*st*, provide for a Commission composed of property qualified rate-payers—say four or six out of every metropolitan electoral district, to be elected by the rate-payers, one-third of the whole body to retire every three years, and to be made eligible to be re-elected; thus would be provided a body corporate directly responsible to the inhabitants, which would not be subjected to too frequent a change of members as to render the commission inefficient and inoperative. This commission should be unpaid, to which I would add two unpaid government commissioners, through whom the commission should be made responsible to the government. This commission should have the power to appoint a permanent working committee of three or five practical men, not members of the commission, but as paid public servants, who should be compelled to devote their whole time and attention to the duties of the commission, which committee should be aided by one government inspector. Thus would the commission be made directly responsible both to the inhabitants and to the government, and the possibility of jobbing on either side precluded; while, at the same time, the best means of securing efficiency, uniformity, and economy in its operations would be attained.

2*nd*. The measure should provide for the establishment of a uniform rate throughout the metropolis, including all its suburban districts, on all existing building erections according to the assessment for the time being, which rate should be charged on the fee-simple of the property, and powers afforded to alter all existing arrangements, not prejudicing the legality of any holding, or terms of tenure, between landlords and tenants—whether leasehold or otherwise, as may be necessary to establish a permanently uniform and continuous water accommodation to every building of whatever denomination; and with respect to all future buildings, of any and every description, the parties so building should be supposed, expected, and compelled to have possessed with the site upon which such building is intended to be erected, a supply of water; such provision of water to be made by the Commission herein provided, and the expense of such provision to be paid for as part and parcel of such site. Or if such site be leased for building purposes, the ground landlord should be compelled to pay for the provision of a water supply, and to make terms with the lessee accordingly; and the water rate should be made in accordance with the fixed assessment on the property, and in all cases to be levied and made compulsorily payable *pro rata* for time of occupation only.

3. The measure should afford powers to the Commission to raise from time to time, upon the security of the rates, any sum or sums of money for the purpose of providing, increasing, and improving the general water supply to the metropolis and its suburban districts; to purchase the plants of existing companies, and to apply the same to sanitary purposes or otherwise; to institute inquiries as to whence water may be obtained in abundance and purity; and to establish an entire new service throughout the metropolis for domestic purposes.

4. The measure should afford powers to institute a board of arbitration between the commission therein provided and the existing water companies, for compulsorily effecting an equitable adjustment of all existing vested interests in the present water supply; for fixing and awarding such a compensation as may, upon due investigation of such interests, appear just and fair; and for fixing and awarding a fair and just price for the present working plants of the companies; and for arranging the payment of the amount of such compensation and purchase as may be agreed upon, either in money, at a specified time, terminable annuities, or in debentures of the commission bearing

four per cent. interest, to be periodically reduced in amount and ultimately paid off.

The above are the main features of my propositions in reference to providing administrative powers over the future water supply of the metropolis. Of course further working details would necessarily have to be provided for in the measure, but these I need not here enter into.

It may here be asked, why should the present companies receive any compensation for vested interests after having so abused the powers the legislature so unwittingly granted to them? I will merely answer that the public must be just if the companies have been unjust. Many of the present proprietors have taken little, perhaps no share, in those abuses; indeed many may be even altogether ignorant of them. The system which we have so much just cause to complain of, and which the intelligence of the age will no longer tolerate, took root with those against whom declamation and confiscation will now avail nothing. There may certainly be many who have taken a lion's share in, and are still desirous to perpetuate, the present monopoly, and undoubtedly would do so if they could; but a line cannot be drawn between those individuals and persons who may recently have invested, at the market premium price of shares, a whole life's earning in the present water supply, upon the faith of existing acts of parliament, and in the honest belief that in providing for a first indispensable necessary in the social requirements of the public, a good object is supported and a safe investment secured; and thus, under such circumstances, many widows and orphans may be, and undoubtedly are, left solely dependent upon such investments for their support. And as the abuses complained of have in part arisen through bad legislation, and it being publicly essential aud imperative to alter the existing system, it would, in my opinion, be both impolitic and unjust not to take such vested rights into fair consideration.

As your columns will, without doubt, be spared to my communication with great difficulty, I will here close this letter, and ask for space at an early date to conclude my observations upon the fiscal part of the question, and also as to the various sources whence an improved supply of water may be obtained.

I have the honour to be,
SIR,
Your most obedient Servant,
JOHN LOUDE TABBERNER

London, March 6, 1850.

WATER SUPPLY OF THE METROPOLIS.

TO THE EDITOR OF THE "DAILY NEWS."

SIR,

In my letter of the 6th inst. I feebly attempted, and I hope not in vain, to prove that water is not a commercial commodity, and that, as public property, it should be administered by a commission, directly responsible to the inhabitants and to government supervision—such as I therein presumed to suggest, or one similarly constituted. In continuation, I will now venture to attempt a concise exposition of the present cost to the inhabitants of the metropolis for the partial and impure water supply as now afforded by the existing companies. I will endeavour fairly to state the circumstances which encompass the question in reference to a valuation of the present working plants, and the relative proportion such valuation bears to the gross stated capital of all the companies. To meet the difficulties of the whole case, and to attain as close an approximation to the amount, it would be fair and just, as between the companies and the public, to pay the former for a transfer of all their working interests to the latter, as the statistical data I possess will enable me. I will also endeavour to elucidate the extreme outlay it will be necessary to provide for effectively improving the quality and rendering a continuous and an abundant water service to every house throughout the metropolis and its suburban districts; and to exemplify the beneficial results which will ultimately accrue to the public in a fiscal point of view, by now adopting an enlightened, liberal, and comprehensive course of action, even such as I humbly submit for adoption; which, under the provisions of a judicious act of parliament, will not necessitate the aid of one shilling from either the government or a rate-payer.

To truthfully approach the present cost of water to those inhabitants now supplied, and the monied position of eight of the present metropolitan companies, it will be necessary to go back to the returns made by each to a parliamentary committee in the year 1834, such returns showing—

1*st.* That in 1833 their respective capitals had been from time to time augmented to the amount and in the manner here stated.

COMPANIES.	Amount of cash capital absolutely subscribed by the shareholders.			Amount of capital acquired from rates levied on the public.			Total accrued capital, representing the works worn out and at present in operation, and upon which dividends are now paid from rates levied upon the public.		
	£.	*s.*	*d.*	£.	*s.*	*d.*	£.	*s.*	*d.*
New River*	500,000	0	0	616,964	0	0	1,106,964	0	0
Chelsea Water ..	70,000	0	0	201,311	0	0	271,311	0	0
West Middlesex .	378,466	6	9	189,579	8	3	568,045	10	0
Grand Junction..	206,000	0	0	125,174	1	7	331,174	1	0
East London ..	436,189	0	0	158,849	0	0	594,988	0	0
South London ..	98,000	0	0	147,306	13	10	245,306	13	10
South Lambeth..	35,920	0	0	146,633	0	0	182,553	0	0
Southwark†	25,000	0	0	....			25,000	0	0
	£.1,749,525	6	9	£.1,585,816	18	8	£.3,335,342	5	5

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* The amount here stated, as paid in cash, is presumed—the company refusing to dissect their capital—to respectively show the amount absolutely subscribed, and the amount acquired from rates.

† The company did not dissect their capital, and the amount being comparatively small, I have stated it as all paid by the shareholders.

2nd. That their respective gross incomes and gross items of expenditure were then as follows:—

	Gross Income from Rates levied upon the public. £.	s.	d.		Gross Expenditure on their works out of their gross income. £.	s.	d.
New River Company	98,307	0	0		38,000	0	0
Chelsea Company	22,906	0	0		13,481	0	0
West Middlesex Company	45,500	0	0		18,000	0	0
Grand Junction Company	26,154	9	0		11,000	0	0
East London Company	53,061	10	0		15,080	0	0
South London Company	9,000	0	0		4,000	0	0
South Lambeth Company	14,808	0	0		6,500	0	0
Southwark Water Company	7,850	0	0	presumed	3,000	0	0
	£.277,586	19	0		£.109,061	0	0

Showing a net income of £.168,525 19*s.*, or more than five per cent. on their gross total capital, or a little under 10 per cent. on the gross actual subscribed capital, leaving the gross acquired capital from the rates made on the public as a bonus to the shareholders on the joint undertakings.

3rd. That the number of houses they then respectively supplied, and the average rates they then respectively levied upon each house were as follows:—

	Number of houses supplied.	Average rate levied on each house by each company. £.	s.	d.
New River Company	70,145	1	6	6
Chelsea Company	13,892	1	13	3
West Middlesex	16,000	2	16	10
Grand Junction Company	8,780	2	8	6
East London Company	46,421	1	2	9
South London Company	12,046	0	15	0
South Lambeth Company	16,682	0	17	0
Southwark Company	7,100	1	1	3
	191,066	8) 12	1	1

Showing an average rate upon each house supplied of...... £.1 10 1¼

Since 1833 there has been no manifest outlay on the part of the companies in improving or enlarging their sources of supply, but we have it admitted by Sir William Clay that the present supply of water from the above eight companies is 44 million gallons per diem, the distribution and public cost of which is made amongst, and levied upon, 259,668 tenants; so that some outlay, it may be fairly presumed, has been incurred in extending pipes, and increasing engine power, but not necessarily to an extent which the increased number of tenants may, at first glance, indicate; for it is possible, indeed certain, that many of their new tenants have been taken on to the service within the range of their plants as constructed in 1833. But to give the present companies the benefit of every doubt, I will presume they have afforded an entire new plant for the accommodation of their new customers, the increased number of whom is 68,602, occupying as many houses, containing an aggregate population, allowing seven persons to a house, of 480,214; and estimating the very outside cost of such an extension of their works, conjointly at £.1* per head of the population so additionally provided for, the joint capitals of the above eight companies would be increased accordingly. Presuming, therefore, that the average rate now charged by the companies conjointly is not less, and it certainly ought not to be more, than they charged in 1833, *viz.*, £.1 10*s.* 1½*d.*, the present gross income of all the companies would be, on 259,668 houses, at that average rate, £.391,124 18*s.* 6*d.*; and supposing the amount of their annual working expenses to have increased at the rate of five per cent., and surely that will will be low enough to satisfy the companies in making a presumed estimate for the ultimate purchase of their present annual income upon their increase of capital of £.480,214, their present working expenses will have increased between 1833 and 1849, from £.109,061 to £.133,071 14*s.*, deducting which latter amount from their present gross income of £.391,124 18*s.* 6*d.*, it will appear that their present net income is £.258,053 4*s.* 6*d.*, or a little under seven per cent. on their gross capital of £.3,815,556 5*s*. 5*d*., or a little under 12 per cent. on their actual subscribed capital of £.2,229,739 9*s*. 6*d*., presuming in the latter sum that the supposed additional outlay of £.480,214 for the accommodation of their increased tenancy since 1833, was subscribed by the shareholders in cash, leaving as I have before pointed out, the acquired amount of capital from rates, *viz.*, £.1,585,816 18*s*. 8*d*. as a virtual, indeed, a positive and absolute bonus to the joint shareholders of all the eight companies. To purchase this position, or to take this annual income of £.258,053 4*s*. 6*d*. out of the hands of the present companies, equitably, and to do equal justice to both the public and the shareholders, is the difficulty to be surmounted in changing the power of control over the future water supply of the metropolis: in making such supply a public, instead of a commercial property. Here, therefore, it is necessary to analyse the stated capital of the companies, and all the circumstances pertaining to its creation and continuous increase, till it has arrived to its present amount. And here it must also be borne in mind that the above estimated gross capital virtually represents and includes every shilling that has ever been laid out in the water supply of London and its suburban districts since the year 1580; for the New River Company, and the East London Company, after over-running all old interests, and thereby reducing them to a mere nominal value, bought such interests, and directly or indirectly capitalised their outlay in making such purchases.

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* In estimating the cost of a water supply to large towns, £.1 per head of the population is supposed to give the required capital for the construction of all necessary works.

I will, therefore, first endeavour to presume or to compute the amount of that portion of the gross capital which represents works worn out and superseded. To approximate this difficult result, I believe there is but one course to take, *viz.*, to ascertain the cost of an entire new plant over the same ground (and this is giving every benefit of the change to the shareholders) as the companies now occupy: and I think it is scientifically admitted on all hands, that a new service extended to every tenement throughout the metropolis, on the most approved hydraulic engineering principles, would not much exceed £.2,000,000. I therefore presume no one can grumble if we take that amount as the value of the absolute working plants of the companies—(most certainly the companies cannot grumble)—and the difference between that sum and the gross capital of £.3,815,556 5*s.* 5*d.*, *viz.*, £.1,815,556 5*s.* 5*d.*, as the representative cost of works long since worn out and replaced by the existing working plants. This, I contend, is a fair way of putting the question of valuation in a commercial form on behalf of the public as against the companies—indeed as between both parties. I shall, therefore, fairly presume that the capital at this present time absolutely employed by the present companies, for the use and accommodation of the public, is £.2,000,000, upon which they receive a net annual income of £.258,053 4*s.* 6*d.*, or more than a 25 per cent. dividend. In purchasing this very strikingly lucrative property we have to take into consideration the dead weight upon it of £.1,815,556 5*s.* 5*d.*, which is represented in the premiums on the shares of the company (for in no other way can it be represented), which premiums are kept up in amount and value by the immense annual income derived upon the absolute and comparatively small amount of capital or value of plant, compared with the gross amount of capital now at work for the accommodation of the community. Nor must it be forgotten that £.1,585,816 18*s.* 8*d.* (as shown in the returns of the companies made to the parliamentary committee of 1833), of the gross capital of which the dead weight of £.1,815,556 5*s.* 5*d.* forms a portion, has absolutely been derived from rates levied upon the public—the party I propose should purchase; and not from subscriptions of the shareholders of the companies—the party I propose should sell; upon the face of which it is plainly, indeed forcibly, manifest, that if a very handsome return for legitimate capital, and an ample provisional annual rest for keeping good the working plants, had at all times only been exacted of the public, the rates could not, nor would ever, have been more than one half the average amount as at this present charged by the companies. With this part of the question, however, it must be considered that some at least, perhaps many, of the present shareholders have morally nothing whatever to do: they purchased their shares at the market premium price; and, although an income of more than 25 per cent. is being derived from the public on the capital absolutely employed, yet not more than 5 or 7 per cent. (as the case may be) is paid on the absolute amount they have invested in the purchase of shares. This must be admitted; and now comes the test of the permanent market value, as between the public and the shareholders, of the present net income of the companies. The present shareholders say they have invested their money upon the faith of the existing acts of parliament, and it is presumed and expected by them, (and I believe by many in the honest conviction that parliament is bound to justify their confidence in such acts of parliaments, under the impression that the present exclusive position of the companies is therein provided for,) that by those acts their vested rights in the water supply of the metropolis will be respected and protected. I allow, under existing circumstances, that it will be right to respect them as far as the purchase of the present working plants by the public extends; but how far the shareholders must look to their acts of parliament to protect their income, as now derived from the public, from depreciation will now clearly and distinctly appear. It must be stated on the part of the public, that in no single instance has any one of the many acts of parliament, from time to time granted to the respective companies, provided that an exclusive district of the metropolis should be entirely and for ever devoted to the absolute benefit and emolument of each company. On the contrary, it was fully expected by the legislature that the principle of "competition by private enterprise," upon which I animadverted in my former letter, would protect the inhabitants from imposition on the part of the companies; and I will do the companies the justice to say, that when they obtained their original acts of parliament, I do not think they ever for one moment contemplated dividing the metropolis into exclusive districts, or of imposing upon the public the oppression of a monopoly which, for the last thirty years, has virtually been a continuous and flagrant violation of the acts of parliament they so obtained. The commercial competition which the legislature, in its inexperience, presumed a water supply would bear, the companies practically discovered would ruin them, if they kept faith with the legislative spirit which had dictated the granting of their several acts; so, in self-protection, they entered into a mutual, and amongst themselves, legally binding arrangement, with which, it must be constantly and unequivocally borne in mind, the legislature had nothing to do, to divide the metropolis into several distinct territories, apportioning one to each under stringent covenants and penalties not to interfere with each other; so that within its own respective and exclusive district each company might charge whatever amount of rates upon the public the shareholders chose in satisfaction of their own selfish purposes, and supply any given quantity of water, more or less, as it was convenient, and of any quality, however impure, without any fear that the inhabitants would obtain relief from this unprecedented and intolerable combination by seeking another source of supply*. The legislature never could have contemplated, or even thought it possible, such an arrangement as this would ever be entered into, to the literal destruction of the social freedom of the inhabitants, or even the shadow of such an abominable coalition would have been carefully provided against; and the public would have been protected from the indiscretions and inconvenient rivalry of the companies at one time, and their oppressive usurious and uncontrollable exactions at another.

Here, then, is the point at which it must be decided, as to how the present monied position of each company has been acquired; how the vested interest of each have been established, and how secured. They cannot claim a prescriptive position. They can only contend for a commercial standing, subject to the same influence of competition as they themselves waged against each other from 1810 to 1820. Their vested interests in the water supply of the metropolis have undoubtedly been established in their own exclusive arrangements; and upon the intrinsic worth of the covenants of their own contract with each other the premium value of their shares must increase or diminish. So far then they evidently cannot look to either the public or parliament for any protection or consideration as a right, in reference to the premium value of their property.

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* The power and vested influence of the existing companies was such as to buy up any new project, or to prevent any *new* company getting a bill through parliament.

I know it may be assumed, and it may be meet for the companies to expect, that competition, under restricted regulations might, under existing circumstances, be submitted to by the public; or the present companies may say, let us continue to supply the metropolis with water under such a supervision on behalf of the public as shall for the future insure to every house an abundance of pure water on such an improved system of service as the adaptability of our plants will allow, and at a cost to the inhabitants as shall not exceed a fair ordinary interest on our present gross and any required increased capital. Such an arrangement as the latter, they may say, will settle the question at once without the necessity of raising money on the future rates to pay us off, or constructing a new plant. They may say we will bind ourselves to afford a supply to every house, and as pure and wholesome as it can be obtained under any new administrative powers of control; by continuing us as servants of the public, you will not interfere with rights which of necessity were founded through the ignorant legislation of the past, and have grown up to a property which ought at least to be dealt with with some sympathy. Our property, they may further say, has been invested for the social good of the community, and although one portion of our capital which has from time to time been employed, was obtained by rates out of the public purse, and although another great portion of the whole, now charged upon the public, represents works not now in existence, and, consequently, of no value, use, or benefit to the present generation, yet we (the present proprietors) have either purchased our shares at their present value, or we have had them left to us as property of such a given value; and why should that value be depreciated while we are so willing as we now profess to be—to which professions we will bind ourselves—to place the future supply of water on such a footing, and under such legal supervisional arrangements, as shall preclude the possibility of a recurrence of any abuse whatever, either in the system of rating, management, or mode of service? To all this I say, that a grave legislative error has been, unfortunately for the public weal, once committed. In the first instance the legislature most wrongly conceded a power which must be legislatively rescinded. The returns of the mortal scourge which lately visited this most wretchedly conditioned city impressed upon the public mind, with unmistakeable woe, the value of a good and wholesome water supply in preserving life and health. In the truth that between 70,000 and 80,000 houses, containing a population of between 600,000 and 700,000 inhabitants physically emaciated and morally prostrated, through being denied a first natural necessity and public right, exists a serious, a fearful responsibility; which those whose imperative duty it is to remove are sacredly bound so to act, as to effectually wipe out this plague spot from the annals of the poor, and to provide such a measure as will for ever preclude its resuscitation. With respect to the depreciation of the premium value of the companies property—such a property as it really is—such premium value is clearly open to the influence of daily changes, and can only be estimated as the circumstances upon which it is based will permit; and those circumstances are such as can hardly claim consideration in any way, either from the public or the legislature, if the question of value was to be dealt with upon its public merits. It may, however, be politic on public grounds, *i. e.*, to facilitate the attainment of a great public good—to afford the relative positions of the public and the companies to be considered on a par, and on one hand concede to an extent the imperious claims of a public right to effectually and for ever destroy a public wrong; and, on the other hand, to make allowance for the supposed misplaced confidence of some of the present shareholders of the companies, in an investment which has grown commercially valuable on that public wrong;—I will so consider and so value the companies' present annual income. And, as regards their continuing to hold the administration of the metropolitan water supply, I contend that no future time can possibly afford a more favourable opportunity than the present for the government to resume that power, which it so erroneously applied in placing the water supply in the hands of trading bodies in the first instance. Under this impression, I believe in the imperative transfer of the present working plants from the companies to a public commission; and will test the value of such plants upon commercial grounds on one side, and public convenience on the other,—absenting from my mind for the moment the question of water being a public property, and the very long and serious public wrongs inflicted, the social rights infringed, the physical comforts compromised, the moral laws broken, and the amount of life and health destroyed through its having been subjected to commercial gains and a capricious power of control. The want of legislative foresight on behalf of the public on one hand, and the legislatively unprotected exclusive arrangements which the companies entered into amongst themselves on the other, is clearly manifest. The aggrieved party—the public—have, however, a remedy left open; they have a just claim on the legislature to redress their grievances—even if no other course was open—by granting such fresh powers to new water companies as would insure competition. The question is, therefore, now open for the public to say whether they will again have the water supply subjected to the influence of "competition by private enterprise," or "municipal regulations." Past experience unquestionably dictates the latter course, but at the same time the present companies cannot deny the right of the public to the former; and in purchasing their plants the public are justified in asking the companies what their plants would be worth in ten years time, provided new companies were introduced and new supplies of water so afforded? And experience from 1810 to 1820 answers the question. They would be worth little or nothing! This competition, however, would inconvenience the public by continually breaking up the streets, impeding business, and occasioning a public annoyance. And in the end it would bring all the companies to a similar necessity as 1820 witnessed—but with this difference to the companies, that such an exclusive and obnoxious arrangement as they then entered into, would not be left open for adoption again in the granting of any new acts of parliament. So in whatever way the question is settled, all monopoly is gone, and not more than a legitimate profit upon capital invested could be gleaned in future. I therefore submit that, under all circumstances, it will be wise, independent of the undoubted right and power of the public to have the water supply restored to municipal control, to meet the companies fairly, and give them—and not bad policy on the part of the companies to accept from the public—ten years' purchase of their present net revenue for the transfer of all, and only their working plants—leaving their retired or rested property, which has accrued from their gains on water, and which is known to be very considerable, especially that of the New River Company, entirely out of the transaction, to their own benefit. Their present net income therefore being £.258,053 4*s.* 6*d.*, which sum being multiplied by 10 (ten years' purchase), the amount of purchase money would be £.2,580,532 5*s*[*].

This presumptive value of the present actual working plants of the companies as created by the purchase of revenue, would exceed the presumed absolute value of an entire new plant by £.580,532 5*s.* I therefore think such an offer, if made, could not be considered otherwise, under all the circumstances connected with the general question, than including a fair respect for the vested rights of all the present shareholders.

I have now to consider the purchase of the respective plants of the Hampstead and Kent Water Companies—the fact of these two companies not having hitherto been included in the accepted category of metropolitan companies, no public returns have been officially made by them upon which any estimates could be presumed with any approximate pretensions to a valuation of their interests. I would therefore include the purchase of these two plants, with the contingencies incident to the general transfer of the whole of the present metropolitan water service to the administrative powers of a public commission, and in perfecting such present service to permanent sanitary uses; for which contingencies I will allow the difference between the presumed amount of the purchase money I have proposed should be paid to the eight companies and £.3,000,000. To this sum I will add £.2,000,000 as the cost of a new continuous service to every house for domestic purposes, making together a total of £.5,000,000* as the extreme necessary outlay for establishing the future water supply, as a public institution, on such a scale as would amply meet all the social requirements of the present and future ages.

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[*] In my former publications I have estimated the amount of purchase money on a presumed revenue, based on the net income of the companies of 1833, without any subsequent data to guide my calculations.

I would here add my humble opinion, that to attain an efficient continuous service a uniform force and motion must, as if taken from one store reservoir, be accomplished, although the supply may be taken from several sources. I do not say that the existing plants could not be made available to a continuous system, but I will venture to say that they would require infinite alterations, at an immense cost, to make them answer the exigencies of such a mode of service.

I will now, in conclusion of this letter, briefly show how I would raise the required sum of £.5,000,000 for the uses of the proposed public commission, how I would repay the same and discharge the current working expences of an efficient water service, and afford, at the expiration of a less period than 30 years, under good management, the whole of the metropolitan water supply at the bare cost of conveyance, and withal, not require so large an average rate from the public—*viz.*, £.1 10*s.* 1¼*d.* —as is now levied by the present companies.

The present population of London and its suburban districts is 2,336,000. The mean number of persons to every house on the south side of London (according to the registrar-general's report) is six, and the average rental of the house is £.25; and on the north side 8, and the average rental of the house is £.46.

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* My former estimates of the total capital required have been based on the purchase of the plants of eight companies only.

I will, therefore (though it is, in fact, rather more), take the mean number of persons to every house throughout the metropolis at 7, and by dividing the number of inhabitants by the same, the number of houses comprising the metropolis will appear as 333,714, say in round numbers 330,000.

An average rate of £.1 7*s.* 6*d.* (2*s.* 7½*d.* less than the average rate now levied by the companies on their tenants) levied on 330,000[*] houses would produce an annual revenue of £.453,750, which sum would enable the proposed public commission for improving and administering the future water supply of the metropolis,

1*st.*—To raise £.5,000,000, upon its debentures, at four per cent.	£.200,000
(or to establish terminable annuities on the same basis).	
2*nd.*—To pay the current working expenses of the water supply to 330,000 houses, affording to each house 175 gallons, or to each individual, of a population of 2,336,000, 25 gallons daily, at an average annual cost of 8s. per house. Estimating the cost of water so delivered, to each dwelling, in accordance with the estimated prime cost of the water supply of the present companies, and also of the proposed supplies of the new schemes now under public notice, at 1½d. per 1,000 gallons, say......	133,000
And 3*rdly*, in addition to the above, afford an annual rest to the gradual liquidation of the principal debt of £.5,000,000, of....................	120,750
	£.453,750

In computing the number of houses as comprising the metropolis at 330,000[†] by dividing the present amount of population by the mean of seven persons to a house, I know I have made an extreme number of tenants; but in estimating the future annual revenue of a universal water supply by an average rate of 27*s*. 6*d*. on that number, I wish it understood that even a greater number of tenants than I have estimated the revenue upon would be subject to the rate by including all manufactories and public places.

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[*] Taking the number of houses as here stated as comprising the metropolis, and the average rent of each house to be £.35 10*s.*, the annual rental of the whole would be £.11,715,000. And taking the annual revenue of the water rate at what I have stated, *viz.*, £.457,750, it will appear that the cost of a water supply under the regulations I have suggested would at first be as near as possible 3¾ per cent. on the gross house rental of tenants supplied.

[†] By deducting from this number 259,668 (the number of tenements now

This annual liquidation of the principal debt would annually reduce the average rate of 27*s*. 6*d*. in proportion to the amount of its product set aside for the reduction of such debt, and the fiscal burdens on the water supply would thus gradually diminish, till the whole debt was progressively paid off, and the inhabitants left in free possession of a natural and public right.

I fear, Sir, I have been betrayed into too great a length; should you, however, deem my remarks on this important subject worthy of further insertion, I shall have pleasure in having afforded them, and will, in another communication, beg to make some observations on the sources available as a new water supply to London, and also on the water bearing stratum of chalks beneath and around the metropolis, and on the different qualities of the water contained therein at different places.

I have the honour to remain, SIR,

Your obedient Servant,

JOHN LOUDE TABBERNER.

London, March, 9, 1850.

supplied with water, as per Sir William Clay's statement) it will appear, even if these supplied tenements were all dwelling-houses, *which is not the case*, that 70,332 houses are at this present unsupplied with water. And as the houses so unsupplied are of the very worst description, and crowded with the poorest and most wretched of our species, it is not improbable, indeed quite certain, that the average number of individuals dwelling in each house will exceed ten. If, therefore, we multiply the number of unsupplied houses—*viz :* 70,332 by 10, we have more than 700,000 of our metropolitan population without that first indispensable article of subsistence —water; to obtain any given quantum of which they are compelled to beg or steal, or barter their existence and stinted earnings away under every social disadvantage, to secure from the demoralising stand-pipe, the publican, the huckster, or the baker a miserable, and it may be said an unsupporting water accommodation.

WATER SUPPLY TO THE METROPOLIS.

TO THE EDITOR OF THE "DAILY NEWS."

SIR,

Having in my former letters endeavoured incontestibly to prove that the administration of our present metropolitan water supply is wrong in principle, and, to the common community, bad in effect; at the same time offering suggestions as to a future titular control and administrative management, accompanied with a presumed practical exemplification of the publicly beneficial results to be derived under the latter, I will now observe on the quantity of water at present afforded; and also upon that which is additionally, and how available, within a given distance of, and under London; and conclude by explaining why the constituents of the water now, and of that which may be supplied are different at different places.

The quantity as at present supplied from every source cannot be correctly arrived at with any degree of certainty. A presumed approximation to the absolute quantity can only be a supposition. I will, therefore, first avail myself of Sir William Clay's statement, that the eight principal water companies supply 44 million gallons daily, and presume the respective quantities supplied by the Hampstead and Kent companies, by the deep borings into the chalk formation, and by land-spring pumps. I will apportion a given quantity as the supply of each company; but in doing so, it must be understood that I have only the district of each to guide me in allotting a relative supply of the whole 44 million gallons from each. The annual money disbursements of each company will not afford a correct data by which such relative quantities may be computed, as it is impossible to say how such disbursements have been actually applied, nor have I any other data which will answer an undoubted inference. I will, therefore, suppose the following quantities to be at present derived from the following sources:—

	Gallons daily.
New River Company	20,000,000
Chelsea Company	3,250,000
West Middlesex Company	3,750,000
Grand Junction Company	4,000,000
East London Company	7,500,000
South Lambeth Company	2,500,000
South London Company and Southwark Company	3,000,000
	44,000,000
Hampstead Company	400,000
Kent Company	1,250,000
Deep wells, called Artesian wells, sunk into the chalk formation	10,000,000
Land-spring pumps	3,000,000
	58,650,000
To which I will add catched rain water	1,350,000
Making a total quantity of water afforded for all purposes of	60,000,000

This quantity distributed equally to 2,336,000 inhabitants would afford about 25½ gallons to each daily. Such a supply, if pure, appears a self-evident good one; but what are the facts pertaining to such a supply in detail? First, at least one-third of the whole must be deducted as running to waste, under the intermittent principle of supply, leaving 40 millions of gallons only for absolute use; from which must be deducted a supply for the following requirements:—

For horses and cattle of all kinds in numbers proportionate to the living wants, artificial necessities, and working powers of this great community.

For slaughtering purposes of every description; for distilleries, breweries, dyers, manufactories, hospitals, prisons, barracks, public places, water-closets, watering streets, and fires, &c., which will undoubtedly take one-half the 40 million gallons, leaving for domestic purposes but 20 million gallons daily, for a population of 2,336,000, about 60⅝ gallons to each of 330,000 houses, or an average of about 8½ gallons to each individual for washing, cleansing, culinary, drinking, and ablutionary purposes; and the whole of a quality, with the exception of a fractional portion, utterly unfit for human purposes, especially the supply on the south side of London.

From these figures the domestic condition of the lower classes may be easily supposed. When the wealthier classes have taken their required portion out of the above stinted whole, the average quantity left for the necessities of the poor will indeed be a couzenaged share; and I do not think I have unfairly conjectured the existing truth. Yet this miserable, this perishing supply, as a whole, costs the inhabitants indirectly,—for we must include the necessary receiving cisterns, butts, &c.—*half a million of money annually*, independent of the cost of cesspools, which, under an efficient system of water supply and drainage, might be entirely dispensed with.

I will now, in the hope of aiding in the attainment of a better, more abundant, and cheaper supply of water to the metropolis, beg to repeat that no apprehension need be entertained in respect to an ample additional supply not being available. I have no hesitation in saying that, if our daily necessities were such as to imperiously require a further supply of 200,000,000 gallons, that quantity of surface water alone, suitable for domestic purposes, might, with ordinary engineering exertions, be immediately conveyed to the inhabitants from sources within a thirty-five mile radii of London.

The average annual depth of rain which falls in the vicinity of the metropolis is 21 inches; and, if we allow even one-half to be taken up by evaporation, though but a third of the whole is the proportion supposed to be so taken up and absorbed in the sustenance of the vegetable kingdom, we have 10½ inches percolating into the earth, and by its own gravity finding vent in the surface channels thereof; and if, by contouring the surrounding country, and taking the vales of the surface, large bodies of water might be collected and stored in various parts from the innumerable land springs which, in those natural catchments, flow as the concentrated drainage of the surrounding surface elevations. The water so collected would vary in quality according to the chemical properties of the different strata it percolated through, but generally speaking it would be good for household purposes, more especially in the south-western districts, where a gravel stratum extends over a vast area. In cases of long drought, however, a permanency of supply from such sources would naturally fail, unless store or artificial catchments were constructed sufficiently large to make a provision in times of heavy falls of rain, against such certain casualties; and I only allude to such sources of supply as introductory remarks to the larger supplies more directly available and more strikingly afforded from the chalk structure around London. The many adjacent surface rivers all take their rise from the springs of the upper portions of the chalk formation, which extends under London beneath the alluvial deposits, and crops out to a greater or lesser extent around us, forming what is commonly called the London basin, the whole area of which is nearly 4000 square miles—*i. e.*, that portion of the chalk structure which may properly be termed the London basin, of which area, as nearly as possible, 1200 square miles crops out and forms the elevations of Hertfordshire, Hampshire, Surrey, and adjoining counties. By taking the whole of the exposed surface of the chalks in Cambridgeshire, Norfolk, &c., there is an exposed area of the formation of about 4000 square miles, but that portion of the chalk surface which may be correctly taken as forming the London basin—*i. e.*, that portion of the formation which forms a catchment available to the metropolis—must be computed from a circle of altitudes forming the highest points of the chalk structure, the surface within which is the area of the London basin, and the exposed surface of the chalk within such given area is, as I have before said, about 1200 square miles. A portion of this latter area is what is geologically called the block or back chalk, and is impervious; consequently, the rain which falls upon it flows over its surface on to the stratified portion of the chalk surface, into and down the fissures of which, with the exception, of course, of what is evaporated, it percolates into the depths of the formation. It is from the springs in the declivities, or surface vales of the chalk, within the altitudes above-mentioned, that the Kennet, Lodden Auborne, Brent, Colne, Verulam, &c., &c., Wey, Mole, Wandle, Ravensborne, &c., Rodding, Lea, Stort, Ware, &c., in all about twenty rivers, take their rise and flow in a metropolitan direction, receiving in their course the natural surface drainage of the land strata, and forming tributaries to the river Thames,—the trunk, or general catchment of the surrounding country,—through which it winds its serpentine course. From several of these rivers the water supply of London may be improved. Several schemes propose new and independent supplies from different parts of the trunk river; another from one of its tributaries, the river Wandle; others to improve the supplies of existing companies from the Ware, Stort, and Rodding. Another scheme proposes to sink shafts into a declivity of the chalk formation at Bushey Mead, in the Vale of the Colne, where it is proposed to raise sufficient water to supply some of the northern districts of London. Another similar scheme has been suggested to supply the south side of London from shafts sunk into the chalk formation on the line of the South Eastern Railway. I will just add that there are numerous plentiful springs of beautiful water in the vales or declivities within the surface area of the London basin, gushing forth and lost in the natural channels around, which might, by a careful contour, be diverted into available sources of supply.

In reference to the gross quantity thus derivable from the various sources here alluded to, it is supposed that from

	Gallons daily.
The river Thames above tidal influence might be taken	100,000,000
From the river Wandle	27,000,000
From the river Verulam and adjacent waters	15,000,000
From the chalk springs at Bushey Mead	8,000,000
From the rivers Ware, Stort, Rodding, and the shafts sunk into the chalk formation, additional supplies might be added to the existing services of the New River and East London Companies of	10,000,000
From the chalk stratum on the east and south of London, by sinking shafts, as at Bushey Mead.	10,000,000
From Rivers Cray, Ravensborne, and diverted springs	2,000,000
	172,000,000
Surface catchments, say at least	28,000,000
	200,000,000

I must not be supposed as advocating the entire collection of all these waters. I merely show that, if necessitated, we might have them. In reference to an improved general water supply to the whole of the metropolis, supposing surface water to be solely sought, I will here observe that, whether such improved supply be obtained from one, two, three, or more sources, all should be conveyed to one grand water store at the highest point of Hampstead for a continuous service to all London: even the New River, if continued as a portion of the domestic supply, should also be diverted to the great store reservoir or reservoirs, for it would be necessary to have two at least. A similar arrangement should be effected on the Surrey side of London if necessary; but I am of opinion that from the Hampstead elevation an abundant supply might be afforded both to the south and north of the metropolis; and in the construction of the new Westminster bridge an aqueduct or aqueducts, of ample dimensions to carry the supply for the south side over the Thames, might be made without damaging the architectural design of the bridge; or the supply for the south side might be carried over the Thames at the different levels of the several bridges by means of iron mains. The reservoirs at Hampstead should be divided into compartments to facilitate cleansing and keeping the water in motion, and thence a uniform hydrostatic force should be attained; thus a universal continuous supply of water to every room of every house throughout the metropolis and its suburban districts might be obtained, and fire brigades, &c., superseded. Such an undertaking would, I am aware, involve the necessity of considerable lifting power; but no waste whatever would ensue, and I believe the whole cost upon the required supply would not exceed 1½*d.* per thousand gallons, even if every drop was filtered.

I will now proceed to say what may be done in another form —I mean by sinking wells into the depths of the chalk formation beneath London, whence I persevere to contend that an inexhaustible supply of wholesome water may be obtained. Not that I expect effectually to impress such a conviction on the public mind, for between the self-interested views of some, the prejudices of others, and perhaps I may add the inexplicable doubts of most, this important available acquisition to the water supply of the metropolis is burdened with such a weight of miscordance, that I fear much time will be lost ere the invaluable truth will be allowed to develop itself.

To afford a comprehensive explanation of the action of hydrostatic laws within this immense water-bearing stratum, would occupy more space than you could possibly apportion to me. I will, however, attempt to make myself understood with as much conciseness and brevity as possible. Opinions upon this most interesting topic vary, and diverge to different theoretical results; and, I am sorry to say, the best of feeling has not been at all times exhibited in the expressions of those who have been supposed to be the most intelligent on the subject, when their views have been opposed and practically refuted. I shall not, however, digress to discuss the personal views of any individual, further than may be essential to illustrate my own. And should I use any untenable remarks, wrongly argue any portion of the question, or use any assertion unsupported by practical facts, I shall feel happy to be corrected, for it is truth alone I am desirous to develop to the public.

There are those who *superficially* denounce the possibility of obtaining water *subterraneously* for the use of the inhabitants of London, as a wild and visionary hope—there are those who, upon the *mere faith* of such denunciation alone, proclaim the impossibility of such an accomplishment—there are others who say there is in *such an idea* "a degree of extravagance and "opposition to nature"—and others who declare that the water contained in the chalk is *all being pumped out of it*, and contend that that which remains is impregnated *with the present sea* water—and there is one gentleman who supports both the last theories, while he writes as follows, and affirms and contradicts a position in the same breath:—

"When many wells were sunk, and powerful steam engines "were erected to raise this water, as soon as more was lifted "than could be supplied through the small pores of the chalk "underlying the London clay, the level of the water was gra-"dually reduced to its present depth of 47 feet below the sea; "and the same fissures which formerly served as a partial outlet "for the upland water became the means of admitting sea water "to replace that thus abstracted."

Now, one moment's reflection will lay bare to the most ordinary mind the fact that, if by pumping out the water of the chalk formation its levels therein had been reduced to 47 feet below the sea, and that if the same fissures which formerly served as an outlet for the upper chalk water became receivers of the sea water into the chalk formation, it is quite certain that the sea water so admitted would *as constantly raise* the water level in the chalk by constant repletion from the sea as the abstraction alluded to *would lower it!* Yet this gentleman and others, to whom I have made allusion, would have it at the same time believed that *the depression of the water level in the chalk continues.*

I would satisfy myself by saying to all this, that I am bound to entertain such descants as mere assertions only, unsupported by any really logical or practical deductions, but which, however, I will in the course of my letter logically refute.

I have before described the surface area of the London basin, within which all the surface rivers rise, and directly flow towards the metropolis. The vale of the whole chalk structure is beneath London, and a considerable portion of the rain and snow waters which fall upon the exposed surface of the chalk within the inclinations of the basin naturally percolates into its depths, whence I contend that a supply of water may be obtained for all the requirements of a population many times larger than London now contains.

Formerly most of the deep wells of London were sunk only into the sand bed above the chalk, the water of which, in some instances, overflowed the surface; but the quantity of water contained in the sand being limited, receiving the greater, indeed, nearly the whole of its supply from the fissures of the chalk elevations beneath the alluvial deposits, as the abstraction thereof has from time to time increased, the wells have ceased to overflow; and the repletion being very limited from the upper chalk fissures, a permanent diminution of the supply from that source, —*i. e.*, the sand bed,—as the number of wells sunk into it have increased, is but a natural result; but it is very different with the chalk stratum as regards quantity of supply, and means of repletion as abstraction increases. I at once admit the fact that the apparent level of the water in the chalk has lowered within the last 50 years, and it would be a contravention of common sense to reason otherwise; but the reason why the supposed level of the water has so materially lowered, I will with deference attempt to show.

The structural form of the chalk is undulated on its surface beneath the alluvial deposits, as the land surface. The chalk rises in one place to within 100 feet of the latter, in another place to within 200 feet, in another it is not reached till within 300 feet, and in another not till within 500 feet of the land surface, and so on. In fact it is hill and dale throughout under the alluvial deposits, as the land surface is hill and dale around us. Into these elevations of the chalk beneath London its fissures ascend, as they also descend into the depths of its formation, immediately beneath which is another bed of green sand which also crops out with the chalk around us, and its surface area is also open to receive the rain. Beneath this lower sand bed is another impervious formation called the weald clay, similar to the body of clay above the upper sand bed, which lower body of clay prevents the water percolating lower down into the bowels of the earth, as the plastic or London clay above prevents the water of the land or surface strata percolating into the sand and chalk formations between the two bodies of clay: thus the sand and chalk formations become independent water bearing strata, cropping out (with the exception of the sand bed above the chalk, the outcrop of which is very trivial) to the surface around London, there receiving the rains of heaven, which by its own gravity percolates into the fissures and depths of the chalk, and also into the depths of the lower sand bed. The hydrostatic pressure thus naturally brought to bear in the chalk forces the water into its varied fissures—the greater portion into the depths of its structure, and some into its elevations—from the latter of which they empty themselves into the upper sand bed from the declivities of such elevations. It is thus that the sand beds above the chalk, and that the upper portion of the chalk formation beneath the alluvial deposits, become partially charged with water.

Before any Artesian borings were made either into the sand or chalk formations both were full of water, and when first tapped—if I may use such a term—the water rose to the surface, but as the number of wells increased that overflow ceased; and as the borings were extended deeper into the chalk, the hydrostatic pressure which forced the water into its elevations became reduced in power, and the quantity of water in the sand diminished; and as the wells into the chalk were deepened and increased in number, the partial quantity of water contained in the upper fissures descended, and thus the apparent great depression of the water in the chalk we have heard so much about has been occasioned. This depression is not to be estimated as of the great body of water contained in the chalk, but merely as the lowering of that portion of the water contained in the upper fissures, which were first and are now partially charged with water by its own natural force. This depression, however, varies as the average quantity of rain and snow falling upon the outcrop varies; and as the pressure, consequent upon the quantity of rain and snow so falling, which forces the water into the fissures of the chalk elevations varies, so will the quantity of water in those elevations, and in the sand bed above, vary, till the abstraction of the water from the depths of the chalk becomes so great altogether as to reduce the general body of water in the formation, and so reduce the pressure which now sustains it in the elevations.

I have by me diagrams showing these elevations of the chalk structure, which I purpose publishing, with a fuller explanation than I can possibly give through your valuable columns, as to the capabilities of this water-bearing stratum to yield an abundant and an inexhaustible supply of water to the metropolis—I affirm abundant and inexhaustible, for so long as the rain continues to fall repletion will always and for ever be afforded. And the green sand bed beneath the chalk will, upon the same principle, always be charged with water, and by boring through the chalk the water of the lower sand formation might also be obtained. There are, however, many circumstances in making artesian borings into the chalk for water, which tend to create doubts and difficulties. In many instances borings have been made into the elevations of the chalk, and, as will already have appeared to the mind from what I have said, not been successful in obtaining water. In other instances, water has been at first obtained, and then lost. The occurrence of all these casualties is certain, till the structural form of the chalk becomes better understood. An elevation of the chalk—a perfect ridge indeed—extends round from Millbank-street, Westminster, Seven Dials, St. George's, Clerkenwell, Brick-lane, Tower-hill, and the well of the Royal Mint penetrates its declivity. There are also other difficulties in boring at Brentford; it would appear that an elevation of the block or back chalk is met with there. Again at Hampstead, they have gone a great depth, and only obtained a partial supply of water; but although their depth is very great from the surface, yet they are not so deep into the chalk formation below Trinity datum as the well at Trafalgar-square; and if they continue to bore into the depths of the chalk they will undoubtedly obtain abundance of water. It is an accepted opinion that by sinking a shaft at Trafalgar-square, similar to the one they have sunk at Hamptead, a body of water sufficient for the supply of the city of Westminster might be obtained; and any one who is acquainted with the vale of the chalk formation, as there evidenced, would not doubt the practical value of such an opinion. With respect to the sand bed above the chalk yielding an abundant supply of water independent of the chalk, as is maintained it does by some, the facts may also be freely tested at the Trafalgar Square works: by there stopping the bore-pipe into the chalk and bringing the pumps to bear on the strata of the sand bed alone, the abstraction will dry the well;—unstop the bore-pipe into the chalk, and the water cannot, to any appreciable extent, be lowered.

It has been accepted as a truth, in prejudice to the certainty of obtaining water from the chalk, that Messrs. Barclay and Messrs. Calverts, the brewers, are compelled to work alternate days in consequence of their wells being subservient to the abstraction of each other. It is well known that all wells sunk only into the sand formation affect each other; indeed, from the pervious character of the formation, it would be impossible it should be otherwise; and when both these firms first sunk their wells into the sand bed only, they undoubtedly did affect each other, but since Messrs. Barclay subsequently extended their bore pipe into the chalk formation, they have received an abundant supply of water, while Messrs. Calverts have not in the least affected them. It is true, however, that the well of Messrs. Barclay has for some time past somewhat diminished in its yield of water, but the cause has been lately discovered. When they first bored into the chalk to improve their supply of water, they continued to avail themselves of the water in the sand by perforating the pipe which passed through the same, to allow the water contained in the sand to percolate through into the well; the consequence was that the sand also percolated through and precipitated into the bore pipe of the chalk, and therein became consolidated to an extent of 73 feet, stopping the free emission of water from the fissures of the chalk. The bore pipe of the chalk has lately been cleaned out, and the level of the water in the well immediately rose.

Messrs. Calverts still pump from the sand bed only, and, consequently, are liable to difficulty and a deficiency of water.

As regards the construction of an Artesian plant throughout London, I know it has been asserted and held forth, that the expenses of the working powers of such a water service would be enormous. To those who are practically acquainted with this part of the question, it is unnecessary to say anything. And I shall merely add, that it would not cost more, if so much, as any other scheme propounded, in proportion to the extent and magnitude of the undertaking. A continuous high service supplied by an Artesian plant, would be most simple and most efficient.

I find, Sir, I must conclude, though I hoped to convey in this communication my remarks upon the properties of the chalk water at different parts of its formation, which remarks will tend to substantiate observations I have herein advanced as facts; I must, therefore, beg permission to forward another letter for insertion in your columns.

And remain, Sir, your very obedient Servant,

JOHN LOUDE TABBERNER.

London, March 13, 1850.

WATER SUPPLY TO THE METROPOLIS.

TO THE EDITOR OF THE "DAILY NEWS."

SIR,

In continuation and in conclusion (for the present at least) of my correspondence on the all-important question of an improved metropolitan water service, I will explain why the water of the chalk formation differs in its constituents at different places, and at the same time testify that the water in the deep wells under London is not impregnated with sea water; and, in doing so, substantiate my former observations in reference to the chalk structure being a medium in which the rains of Heaven collect and form a continuous, inexhaustible, and wholesome source of water supply available to the uses of this great and populous city.

It is necessary, in the first instance, to give an analysis of the water of the chalk as obtained at different places; I will, therefore, make use of the water as raised from the respective wells at the government works, Trafalgar Square, at the Brewery of Messsrs. Combe and Delafield, at the Royal Mint, and from the chalk formation at Bushy Mead, near Watford, to which I will add the analysis of the water of the river Thames, above and within the influence of the London sewerage, as containing chalk water.

Water from the chalk formation Bushy Mead, near Watford:

	Grains.		Grains.
Carbonate of lime	19.54		
Sulphate of lime	0.94		
	——	Hardening constituents	20.48
Chloride of sodium		Common salt	1.90
Carbonate of iron			1.32
		Solid contents, per gal	23.70

Water from the Trafalgar-square deep well:—

	Grains.		Grains.
Carbonate of lime	3.255000		
Carbonate of magnesia	2.254000	Hardening constituents	5.509000
Chloride of sodium		Common salt	20.058500
Phosphate of lime	0.034041		
Sulphate of potassa	13.671000		
Sulphate of soda	8.749300		
Phosphate of soda	0.291000		
Carbonate of soda	18.048800		
Silicic acid	0.971000		
Apocrenic acid	0.098700		
Crenic acid	0.137200		
Extractive matter	0.672000		
			42.673041
		Solid contents, per gal.	68,240541

Water from the deep well at Messrs. Combe and Delafield's brewery:—

	Grains.		Grains.
Carbonate of lime	6.18		
Carbonate of magnesia	1.08	Hardening constituents	7.26
Chloride of sodium		Common salt	12.74
Phosphate of lime	0.19		
Perphosphate of iron	0.24		
Sulphate of soda	24.25		
Carbonate of soda	11.68		
Silicic acid	0.44		
			36.80
		Solid contents, per gal.	56.80

Water from the deep well at the Royal Mint:—

	Grains.		Grains.
Carbonate of lime	3.50		
Carbonate of magnesia	1.50	Hardening constituents	5.00
Chloride of sodium		Common salt	10.53
Sulphate of soda	13.14		
Carbonate of soda	8.63		
Silica	0.50		
Organic matter	traces.		
Iron	traces.		
Phosphoric acid	traces.		
			22.27
		Solid contents, per gal.	37.80

Water from the river Thames above the influence of London sewerage:—

	Grains.		Grains.
Carbonate of lime	12.75946		
Carbonate of magnesia	1.02711		
Sulphate of lime	0.45073		
Chloride of calcium	1.75021		
		Hardening constituents	15.98751
Sulphate of potash	0.66794		
Sulphate of soda	2.00011		
Silicic acid	0.27314		
Phosphoric acid	traces.		
Carbonate of oxide of iron			
Alumina			
			2.94119
Soluble organic matter	2.28536		
Insoluble organic matter	1.19483		
		Organic matter	3.48019
		Solid contents, per gal.	22.40889

Water from the river Thames within the influence of London sewerage:

	Grains.		Grains.
Carbonate of lime	8.1165		
Chloride of calcium	6.1165		
		Hardening constituents	15,0906
Chloride of sodium		Common salt	2,3723
Sulphate of potash	0.2695		
Sulphate of soda	3.1052		
Chloride of magnesia	0.0798		
Silicic acid	0.1239		
Phosphoric acid	traces.		
Alumina			
			3,5784
Soluble organic matter	2.3380		
Insoluble ditto	4.6592		
		Organic matter	6.9972
		Solid contents, per gal.	28,0385

With respect to the action of all the constituents I have noted as hardening the water, I am aware that doubts may be entertained as to the fact of their being hardening constituents. The conclusion that they are so, however, is the result of long and deep investigation by a very able practical chemist; and I have not ventured to put them forward as such without being fortified with the capability of substantiating such conclusion.

The constituents of the chalk water from the above four sources vary, it will be perceived, in quantity and number most remarkably. The Watford water is nearly four times as hard as the water of the Trafalgar Square well; nearly three times as hard as the water of Messrs. Combe and Delafield's well, and four times as hard as the water of the Royal Mint well—the three latter containing counteracting (*i. e.* softening) constituents, while the Watford water contains none whatever.

The Watford water contains but nearly 2 grains of common salt, and in all 4 constituents; the Trafalgar Square well water contains better than 20½ grains of common salt, and in all 12 constituents; the well water of Messrs. Combe and Delafield contains 12¾ grains of common salt, and in all 8 constituents; and the Royal Mint well water contains 10½ grains of common salt, and in all 9 constituents. I mention these particulars in order to make my further observations intelligible.

If water contains more than 10 grains of hardening constituents, it is termed "hard water." The Watford water as above is therefore a "very hard water," more so than the Thames water by many degrees; indeed, were it not for the impurities in solution consequent upon the London sewerage and the organic matter contained in the Thames water, the Watford water would for all purposes be very inferior to it. The Thames water, however, is essentially hard, while the water of the deep wells under London is purely soft; at the same time containing no constituents, though many but what are, upon the whole, intrinsically wholesome and necessary natural adjuncts to animal subsistence.

I have heard one of the gentlemen I have already alluded to in my last letter—and, indeed, whom I quoted by way of illustrating the subject—adduce the difference in the properties of the chalk water raised respectively at Bushey Mead, near Watford, and at London, in support of his advanced theory, that the rain which falls on the denuded surface of the chalk in Hertfordshire passes directly away through deep subterraneous fissures into the sea, and that it does not percolate into the depths of the chalk formation beneath London; and that the water in the deep wells in London is some other, and for the most part sea, water. Other gentlemen, as I have before intimated, also argue that the water in the depths of the chalk under London is impregnated with sea water. I will endeavour to show the amount of value to be attached to the views, or rather the theory of these gentlemen respectively. With respect to the former advancing as a fact, that the rain which falls upon the exposed surface of chalk in Hertfordshire, percolating down into deep subterraneous fissures, and through them passing away into the sea, I will simply say, that if such was really the case, it is very remarkable, indeed quite incomprehensible, because quite opposed to all the received and acknowledged principles of hydrostatics, that if there is a great vent—a direct outlet—below, or rather in the depths of the chalk, that water should rise, in fact gush out upon the surface, and form the innumerable springs and many rivers which are witnessed within the inclinations of the exposed portion of the chalk formation—if these subterraneous passages did exist, it is certain, beyond all cavilling, that neither springs nor rivers would be manifest on the surface of the chalk basin, nor should we have any supply of water in the chalk formation beneath London. Indeed, these immense deep fissures—for immense it is said they are—would act as a perfect system of drainage to the upper portion of the chalk formation, and the rain falling thereon would, by its own gravity, make its exit through those immense subterraneous fissures. We have, however, self-evident facts, which in themselves at once destroy the presumption that such fissures do exist. We have water in the chalk formation beneath London in abundance; and we have also springs and rivers in superabundance on the surface within the inclinations of the chalk formation, which would otherwise be subjected to the influence of the universal drainage such subterraneous outlets would most positively involve. Even the London (Watford) Spring Water Company virtually assert as a body that no such subterraneous fissures exist, for they say they can obtain any quantity of water, even eight millions of gallons per diem, from Bushey Mead; yet, strange to say, one, I may say the principal, advocate for the success of the company in obtaining its desired powers from parliament, advances the hypothesis I have alluded to, in direct opposition to the very scheme he himself has so much interest in supporting.

The rain, as it naturally falls, is a distilled water. The atmospheric gases are supposed to be composed of one-fifth of oxygen and four-fifths of nitrogen, and as the rain descends in its pure state it takes up a larger portion of oxygen than nitrogen; and as it so falls upon and into the earth it converts carbonaceous matter into carbonic acid, the latter rendering the water capable to dissolve lime, and so a solution of carbonate of lime is produced. The longer, therefore, the water is exposed to the atmosphere the more oxygen gas will be involved, till saturation is complete, and, consequently, become more powerful to produce carbonic acid; and as an increased proportion of carbonic acid is taken into the water the more powerfully will it act upon and hold more lime in solution—thus the carbonate of lime will increase in quantity, and, the latter being a hardening constituent, the hardness of the water will proportionately increase.

The reason why the water of the chalk is so much harder at Bushey Mead, near Watford, than in the depths of the structure under London is very simple, and, consequently, very apparent. The water at Watford is taken from the surface fissures of the chalk, or rather in a declivity, or surface vale; it therefore follows that a portion of the rain which falls upon the upper portion of the vale flows down the surface, and enters the fissures in the declivity and in the vale. Such portions of the rain which so flows over or down the surface, is exposed a longer time to the atmosphere than that portion which percolates immediately into the fissures of the chalk, where it directly faces; the rain which therefore falls and flows over the surface being longer exposed to the atmosphere by the agency of the oxygen gas it contains, involves more carbonic acid, dissolves more lime, and holds more carbonate of lime in solution, than the rain water, which immediately penetrates the chalk formation, and descends into its depths—hence the water is hard at Watford and soft under London; at which latter place, however, it varies in respect to its degrees of hardness in every deep well, in proportion to the time the rain water has been exposed to the atmosphere, more or less, before it penetrates the upper or exposed surface of the chalk.

It may be here asked, if this is really the case, how is it that this Watford water when collected in a tank becomes soft by exposure to the atmosphere? I simply say, because the oxygen in the water has no more carbonacious matter to act upon, consequently no more carbonic acid is involved, and that carbonic acid which it already contains escapes, and the lime held thereby in solution precipitates, and the water becomes soft; but if the same water is again allowed to act upon lime, it will again become hard—even harder than ever.

With respect to the saline constituents of the chalk water differing so much in different wells, the cause is as simple as the process of hardening by the naturally produced agency of carbonic acid, though the latter has no effect whatever on the soluble salts contained in the chalk water.

It will be perceived that in the Watford water there are only two soluble constituents—a little chloride of sodium, and a little carbonate of iron—while in the water in the chalk formation under London, in three different places, the soluble constituents range from six to ten in number. The reason is this: the Watford water travels no distance through the chalk formation, and consequently does not come in contact with similar substances as the rain water, which travels a greater distance through the chalk, and thereby comes in contact and takes up the numerous soluble salts contained therein;—hence it is found that the rain water in every deep well in London, which has percolated down from the exposed surface of the chalk, differs in the quantity and number of its constituents, more or less, according to its velocity through or over the different substances it has acted upon and dissolved in its varied course through the chalk,—the chemical properties and quantities of such substances being as diffused and as varied as the mind can imagine from the deposits of an ebbing sea.

Before any deep borings were made, or any pumping from the sand and chalk formations commenced, undoubtedly they were, as stated in my last letter, both charged with water; and the natural outlet or lip of the formation being only of a given depth, at a given point of the chalk deposit—the retiring course of the tertiary ocean—the motion of the water contained in the depths of such deposit, below the level of its outlet, has been very partial; while its drift above the level of its outlet has been according to the force of its own gravity. The lower water, *i. e.*, the water contained in chalk below the outlet or lip of the basin, will be found to be more strongly impregnated with saline constituents—the original deposits of the tertiary seas—than the water therein will be when constant abstraction shall have occasioned a larger and more rapid repleting current from the exposed surface of, and through the formation. The saline constituents of the chalk water, as now discovered, will continue to exist in a greater or lesser amount according to the stagnated condition of the water in the depths of the structure. As the water is more frequently changed by abstraction and repletion the amount of its saline constituents will diminish, and the purer it will continually become. The above analysis of the water, as contained in the deep well at Trafalgar Square, was made two years ago. In a recent analysis of the water, as now being raised from the same well, the saline constituents have diminished in amount. The quantity of carbonate of lime is reduced to 1.8 grain, indicating a more rapid descent from the surface, which has undoubtedly been occasioned by the enlargement of the fissures of the chalk by the continual friction of the water which now flows to the bore pipe of the well in greater abundance than it did when the works were first constructed.

In reference to the water of the chalk being highly chalybeate as is supposed it is in some of the deep wells, I do not believe that such is really the case to any sensible or depreciable extent any where. It was rumoured that the water as raised from the well sunk at the Euston Square Railway Works, was so impregnated with mineral substances that it could not be used for every purpose; and such was, indeed, to a very great extent, apparently quite true; but the water so raised did not contain such properties from the chalk. In constructing the upper part of the well they had not securely stopped the surface drainage from descending into the well; and it is well known that the substrata of and around Hampstead contains mineral properties, the drainage of which penetrated, as I have just intimated, into the well. Thus was the water, as raised from the first well constructed by the North Western Railway Company, made chalybeate. The company have since more perfectly constructed another well into the chalk, close by the first, from which they derive an abundance of wholesome water, which they supply to all their tenants; and since their possession of such last supply, the Hampstead Water Company have lost the water supply of all the company's property.

The chloride of sodium, which is the common salt, and one of the chief of the several soluble constituents of the chalk, nature, is an original deposit of the Tertiary Seas, and is not produced from the filtration of the present sea water into the chalk formation. And with respect to the statement that the water of the deep wells under London is impregnated with sea water by the latter percolating through "the fissures which "formerly served as a partial outlet for the upper chalk water," I beg most emphatically to say that such an event is impossible unless it can be proved that such vacant fissures do really exist, or that a positive contravention of the natural laws of hydraulics takes place, and that the sea water flows out of its natural course against the hydrostatic pressure of the chalk water. It is further contended by some of the gentlemen I have had occasion to allude to, that the sea water is received into the chalk formation under tidal influence, where the chalk is otherwise denuded; and indeed from the surface of that portion of the chalk which extends under and partially forms the bed of the outlet of the chalk formation into the sea. Now a moment's reflection will convince the most illogical mind that by natural pressure the greater portion of the rain water falling upon the exposed altitudes of the chalk, and percolating down its fissures, more directly forces its way to the lower portions of the chalk structure; and if any outlet exists, if it be only a partial one, at any given point of the structure, the rain falling upon its upper portions will, by its own hydrostatic force, descend and rise to the level of such outlet. Hence immediately you tap the chalk fissures at Gravesend, or at any of the lower parts of the formation, beautiful soft fresh water, and not sea water, is available; even the force of this pressure is evidenced in the fresh water springs in the bed of the ocean itself at low tide; and I contend while this hydrostatic pressure continues from the elevations of the chalk formation—and continue it will, as long as the rains continue to fall—that even if the sea water flowed, as indeed it undoubtedly does, over some of the bare portion of the structure, it would not penetrate into the latter against the force and motion of the fresh water. In further corroboration of the truth of what I advance, I will add that the rain which falls upon the convexinal or external exposed portion of the London basin, *i. e.*, on the outer declivities of the circle of altitudes of the chalk formation, the inner inclinations of which I have described as the London basin—percolates through the convexinal fissures and by hydrostatic pressure is forced to the lower surface of the chalk structure which crops out round the coast, where fresh water, and not sea water, may anywhere, as at Gravesend, be obtained in abundance. And, further, if the water in the deep wells under London was sea water, the water of each well would be nearly, if not quite identical—instead of which the water in one well differs in its constituents from every other—there are no two alike.

In support of my contradiction to the assertion that the chalk water is impregnated with sea water, I beg to say that in a recent most cautiously careful analysis of the water as now raised from the deep boring at Trafalgar Square, purposely made to ascertain whether or not sea water was present, not even a trace of iodine could be discovered, nor did it contain any sulphate of lime, both of which constituents, if indeed the chalk was impregnated with ordinary sea water, as is alleged, would most certainly have been found.

I will here just notice, although I have before indicated the same, that the same pressure which produces the springs by charging the lower surface fissures of the chalk structure, also acts at the same time in producing springs from the upper surface fissures: hence the river Thames, being in itself the natural vale of the country through which it passes, contains in its bed and in its tributaries many chalk springs, and, consequently, the constituents of the river Thames water above tidal influence, are very similar to the water direct from the chalk formation.

Upon the faith of the accuracy of the views I have now enunciated, I am bound to esteem the theories as promulgated by those gentlemen I have in the course of my correspondence alluded to, as untenable assertions, fancies of the brain, unsupported by a single known fact.

Before I conclude I will beg just to notice a paragraph of an article headed "The Institution of Civil Engineers," which has lately gone the round of the papers, referring to a discussion held at the institution here mentioned on the Rev. Mr. Clutterbuck's paper "On the Alternations and Depressions in "the Chalk Water Level under London." The paragraph to which I allude is this,—"The practical conclusion to be "drawn from the observations, recorded in the author's several "papers were: That the natural drainage and replenishment "of the chalk stratum might be traced and accounted for "by observing the alternations of the level in various localities "and at different seasons. That any large quantity of water "abstracted from the chalk stratum, at any given point, caused "a depression of level around the point of such abstraction. "That in the upper district any such abstraction of water

" would interfere with, and diminish the supply of, the streams " by which the drainage of the district was regulated; and, " lastly, that the depression of level under London, by pumping " from Artesian wells, had proved that the rapidity of demand " already exceed that of supply, and that any attempt to draw " a large additional quantity for public use, would be attended " with disastrous consequences." I attended this discussion, if it could be so termed, and I am not aware that any such practical conclusion was arrived at as, " that the depression of the level " under London, by pumping from Artesian wells, has proved " that the rapidity of demand already exceeded that of supply, " and that any attempt to draw a large additional quantity of " water for public use would be attended with disastrous consequences." That Mr. Clutterbuck stated as much I admit; but that such a conclusion was arrived at as a practical truth, and as the result of the discussion, I am bound to deny: and I, as an individual invited to attend and take part in the discussion, have a right to express my deep and painful regret that such an unfair, delusive statement should have been sent forth for publication. Two or three gentlemen at the discussion supported Mr. Clutterbuck's views to some extent; but that any practical conclusion was deduced, unless it was a private one amongst those two or three gentlemen, is utterly untrue. And, in addition to the practical demonstrations constantly in operation, I believe what I have advanced in my former and present communications prove beyond all power of contradiction, that such a conclusion cannot be truthfully substantiated. In respect to the other portion of the paragraph in question, I think any remarks I might have made upon it have also been given in my general observations on the subject.

Finally, as I commenced with the London (Watford) Spring Water Company, I will close with them. I object to their scheme because their water is very hard and unsuitable for all purposes; and because, if water is to be raised from the chalk formation, there is no necessity to go to Watford for it while it can be obtained in as great an abundance, and more suitable for domestic purposes, from beneath London: but more especially do I object to it because, as I at first observed, it is brought forward under the auspices of a joint stock company, which, if tolerated, would result in the formation of another monopoly, although they now promise to charge an average rate of only £.1 upon 40,000 houses, while, according to their own showing, their working expenses will not exceed 8*s*. per house.

Kindly thanking you for the insertion of my letters in your important columns, I beg to remain,

SIR,

Your most obedient Servant,

JOHN LOUDE TABBERNER.

London, March 15, 1850.

LONDON:
PRINTED BY T. BRETTELL, RUPERT STREET, HAYMARKET.

ON

TUBULAR GIRDER BRIDGES.

ON

TUBULAR GIRDER BRIDGES.

BY

WILLIAM FAIRBAIRN, M. INST. C.E.

WITH AN ABSTRACT OF THE DISCUSSION UPON THE PAPER.

EDITED BY

CHARLES MANBY, M. INST. C.E.,

SECRETARY.

EXCERPT MINUTES OF PROCEEDINGS, VOL. IX.
OF THE
INSTITUTION OF CIVIL ENGINEERS.

BY PERMISSION OF THE COUNCIL.

LONDON:
PRINTED BY W. CLOWES AND SONS, STAMFORD STREET.
1851.

INSTITUTION OF CIVIL ENGINEERS.

March 12, 1850.

WILLIAM CUBITT, President, in the Chair.

No. 826.—"On Tubular Girder Bridges."[*]

By William Fairbairn, M. Inst. C. E.

Doubts having been entertained as to the ultimate security of the Torksey Bridge, over the River Trent, the Author has investigated the subject with the utmost care and attention.

A difference of opinion appears to exist,—

1st. As to the application of a given formula[†] for computing the strength of wrought-iron tubular girders.

2ndly. As to the excess of strength that should be given to a tubular-girder bridge, over the greatest load that can be brought upon it; and,

3rdly. As to the effects of impact, and the best mode of testing the strength, and proving the security, of the bridge.

These appear to be the chief points at issue: and, as a reply to both parties by whom he has been consulted, the Author has endeavoured to enunciate such views as will, he trusts, settle the question, and prove satisfactory as to the strength and other properties of these important structures. Previous to entering upon the investigation, it may, however, be requisite to offer a few remarks relative to the construction, and other matters connected with the permanency and security of this description of bridge.

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[*] The discussion on this paper extended over portions of several evenings, at different periods, but the abstract of the whole is given consecutively.

[†] *Vide* page 5.

Every structure having for its object public convenience and the support of a public thoroughfare, should possess within itself the elements of undeniable security. Bridges and viaducts should especially contain those elements, as they are peculiarly liable to accident; and from whatever cause such accident may arise, the community must be equally interested in the strength and durability of the structure. In the introduction of a new system of construction, comprising the use of a new and comparatively untried material, it behoves the projector, on public grounds, to be careful and attentive to the most minute circumstance directly, or indirectly affecting the security of the bridge. In those of the tubular construction, considerations of this kind are of primary importance, as much depends, not only upon the principle of construction, but upon the quality of the material employed and of the workmanship introduced, which in every case should be of the very best description.

In the construction of tubular-girder bridges, the Author has endeavoured to apply these principles; and having a strong conviction of their great superiority in strength, durability, and cheapness, for traversing large spans, he has not hesitated to advocate their introduction. It, however, becomes necessary, from time to time, to submit them to a rigid examination, and before opening such bridges as public thoroughfares, it is essential to subject them to severe and satisfactory tests. These tests and examinations have been various and frequent, and it may safely be affirmed, that in no case, where tubular-girder bridges have been duly proportioned and well executed, has there been the least reason to doubt their security.

The first idea of a tubular-girder bridge originated in a long series of experimental researches, and during their first application to railway constructions, the utmost precaution was observed in the due and perfect proportion of the several parts. These proportions were deduced from the experiments made at Millwall, upon the model of the Britannia Tubular Bridge; and, after repeated tests upon a large scale (full size), the resisting powers and other properties of this kind of bridge were fully established. From these experiments a formula was deduced, for calculating the ultimate strength of every description of bridge, from 30 feet up to 300 feet, or even to 1000 feet span; and as that formula is now before the public, it is believed, that it may be relied upon as perfectly accurate. To relieve it, however, from anything like ambiguity, it will be well to state, briefly, certain points which should be taken into consideration in its application.

It has already been determined by experiment, that in order to balance the two resisting forces of tension and compression in a wrought-iron tubular girder, having a cellular top, that the sectional area of the bottom should be to the sectional area of the top, as 11 to 12; which being the correct relative proportion of those parts, it then follows, that by any increase to the one, without a proportionate addition to the other, the bridge will be rendered weaker; inasmuch, as increased weight is given to the girder by the introduction of a useless quantity of material, which, in this instance, is totally unproductive. This being the case, it is of importance to preserve, as nearly as possible, the correct relative proportion of the parts, in order to ensure the maximum of strength in the two resisting forces of tension and compression—an arrangement essentially important in these structures, and also in the application of the formula to determine the ultimate strength of the girder. If, for example, an excess of material was given to the bottom of a girder, the formula, $W = \frac{a\,d\,c}{l}$, would not apply, as the top and bottom areas would be disproportionate to each other, and that in excess would have to be reduced to the due proportion of 11 to 12; or, in other words, the additional strength must be omitted from the calculation, in computing the strength of the bridge. The same reasoning will apply, where the excess of area happens to be in the cellular top, although in this case the formula, $W = \frac{a\,d\,c}{l}$, still applies, as the excess cannot be considered in the calculation of the strength of the girder.

Assuming, however, that these proportions are maintained, the above formula furnishes a correct principle, on which to estimate the strength of wrought-iron tubes of this description, whatever may be their depths, or their relative dimensions.*

In the case of the Torksey Tubular Bridge, of 130 feet clear span, the following are the dimensions of the girders in the middle, as given by Mr. Fowler (Plate 11):—

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* Mr. Tate, an eminent mathematician, remarks upon the formula—

1st. With respect to $W = \frac{a\,d\,c}{l}$, where a is the area of the section of the bottom, and $c = 80$, the constant deduced on this supposition, will apply to all depths of the tube, within short limits of error, where such depths, or a are large in proportion to the depth of the cells, and the thickness of the plates.

2nd. With respect to the formula $W = \frac{a\,d\,c}{l}$, when a is the area of the whole section, and $c = 26 \cdot 7$, then the tubes should be similar in all respects, but a slight variation in depth, from that of similar form, will not produce much error, especially where the depth is considerable. At the same time it must be observed, that both formulæ apply with great exactness, where the tubes are similar.

SECTIONAL AREA OF THE TOP.

	Ft.	In.		In.		In.		In.
Longitudinal plates . .	2	8⅝	×	2	×	⅜	=	24·47
Vertical plates	1	1¼	×	3	×	$\frac{5}{16}$	=	12·42
Angle iron	0	4¾	×	9	×	$\frac{5}{16}$	=	13·35
Area of cellular top as given by Mr. Fowler .								50·24
Ditto, as given by Capt. Simmons								51·72
Mean								50·98

SECTIONAL AREA OF THE BOTTOM.

	Ft.	In.		In.		In.		In.
Longitudinal plates . .	2	9	×	2	×	⅝	=	41·25
Centre strip	1	0	×	¾			=	9·00
Packing strip	0	3¾	×	2	×	$\frac{10}{16}$	=	4·68
Area of the bottom . . .								54·93

Here there is an evident want of proportion, the bottom being greatly in excess of the top, which renders a reduction of the area of the bottom of the girder from 54·93 to 46·76 absolutely necessary. Hence, by the formula, $W = \frac{a\,d\,c}{l}$, or, $\frac{46{\cdot}76 \times 120 \times 80}{1560} =$ 287·7 tons, or 288 tons the breaking weight in the middle. From this is given 288 × 4 = 1152 tons, as the breaking weight, equally distributed over one of the spans of the Torksey Bridge, neglecting the weight of girders, ballast, rails, chairs, &c., which are differently estimated, but must be deducted from the breaking weight of the bridge.

Mr. Fowler estimates an equal distribution of the load on the Torksey Bridge, of a span of 130 feet, as follows:—

	Tons.	Tons.
Rails and chairs	8	= 177
Timber platform	15	
Transverse beams	27	
Ballast, 4 inches thick	35	
Half the weight of the four girders, which are each 46 tons in weight (it should have been the whole weight when equally distributed)	92	
To this must be added the rolling load, as agreed upon between Mr. Fowler and Capt. Simmons		= 195
Total load		372 Tons.

Now as the ultimate strength of the bridge is 1152 tons, it follows, that 177 being a constant will reduce its bearing powers to 1152 − 177 = 975 tons, as a resisting force to the heaviest rolling load that can be brought upon the bridge, being in the ratio of 975 to 195, or 5 to 1.* These appear to be the facts of the case; and although the principal girders do not attain the standard of strength which the Author has ventured to recommend, as the limit of force; they are, nevertheless, sufficiently strong to render the bridge perfectly secure. In the calculations for estimating the strength of bridges of this description, it is always assumed, that the proportions of the top and bottom of the girder are not only correct, but that the sides are sufficiently rigid to retain the girder in shape. It is further assumed, that the whole of the plates are in the line of the forces, and that the workmanship and riveting are good.

On the excess of strength that should be given to girder bridges, there is a difference of opinion. The Author, however, entertains a conviction that no girder bridge should be considered safe, unless it be tried under four times the greatest load that can be brought upon it; and in wrought-iron tubular-girder bridges, the breaking weight is computed at 12 tons to the lineal foot, inclusive of the weight of the bridge, or about six times the maximum load.

On this calculation, the Torksey Bridge should have been constructed according to the following tables (page 8), which exhibit the strengths, proportions, and other properties of the girders, which are recommended in structures of this kind, and for spans from 30 feet up to 300 feet.

The first column gives the length of the clear span from pier to pier.

The second, the breaking weight of the bridge in the middle.

The third, the area of the plates and angle-iron of the bottom of the girder.

The fourth, the area of the cellular top; and

The last column, the depth of the girder in the middle.

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* It is considered by some engineers, as very important to the strength of these bridges, that the girders should be continuous, or extending over two, or more, spans. This is, no doubt, correct to a certain extent, and although the fact is admitted, yet this consideration is nevertheless purposely neglected, in these calculations; any auxiliary support of that kind acting merely as a counterpoise. It is considered safer, to treat the subject on the principle of compassing each of the spans with simple and perfectly independent girders.

TABLE showing the Proportions of TUBULAR GIRDER BRIDGES, From 30 to 150 feet span; where the depth of the girder is $\frac{1}{13}$th of the span.*

Span.	Centre Breaking weight of Bridge.	Sectional Area of bottom of one Girder.	Sectional Area of top of one Girder.	Depth at the Middle.	
Feet.	Tons.	Inches.	Inches.	Feet.	In.
30	180	14·63	17·06	2	4
35	210	17·06	19·91	2	8
40	240	19·50	22·75	3	1
45	270	21·94	25·59	3	6
50	300	24·38	28·44	3	10
55	330	26·81	31·28	4	3
60	360	29·25	34·13	4	7
65	390	31·69	36·97	5	0
70	420	34·13	39·81	5	5
75	450	36·56	42·67	5	9
80	480	39·00	45·50	6	2
85	510	41·44	48·34	6	7
90	540	43·88	51·19	6	11
95	570	46·31	54·03	7	4
100	600	48·75	56·88	7	8
110	660	53·63	62·56	8	6
120	720	58·50	68·25	9	3
130	780	63·38	73·94	10	0
140	840	68·25	79·63	10	9
150	900	73·13	85·31	11	6

TABLE showing the Proportions of TUBULAR GIRDER BRIDGES, From 160 to 300 feet span; where the depth of the girder is $\frac{1}{15}$th of the span.

Span.	Centre Breaking weight of Bridge.	Sectional Area of bottom of one Girder.	Sectional Area of top of one Girder.	Depth at the Middle.	
Feet.	Tons.	Inches.	Inches.	Feet.	In.
160	960	90·00	105·00	10	8
170	1,020	95·63	111·56	11	4
180	1,080	101·25	118·13	12	0
190	1,140	106·88	124·69	12	8
200	1,200	112·50	131·25	13	4
210	1,260	118·13	137·81	14	0
220	1,320	123·75	144·38	14	8
230	1,380	129·38	150·94	15	4
240	1,440	135·00	157·50	16	0
250	1,500	140·63	164·06	16	8
260	1,560	146·25	170·63	17	4
270	1,620	151·88	177·19	18	0
280	1,680	157·50	183·75	18	8
290	1,740	163·13	190·31	19	4
300	1,800	168·75	196·88	20	0

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* The Author has generally taken the depth of the girders at $\frac{1}{15}$th of the span: but in cases where the span does not exceed 150 feet it has been found more economical to adopt one-thirteenth of the span. For spans above 150 feet it is, however, more convenient, on account of the great weight of the girder, to adhere to the original proposition of one-fifteenth, in order to keep the centre of gravity of the girder as low as possible, and to prevent oscillation under a passing load. In situations where it is objectionable to increase the depth of the girder, it then becomes essential to increase the sectional areas of the bottom and of the cellular top, in the ratio of the depths.

In these tables, the breaking weights of all the girders are calculated from the formula $W = \frac{a d c}{l}$; as for example: — Taking from the table a bridge similar to that at Torksey, 130 feet span; W = the breaking weight, a = area of the bottom 63·38 inches, d = 120 inches, the depth of the girder, c = 80 the constant deduced from the experiments, and l = the length, 1560 inches, between the supports.

Hence $W = \frac{63 \cdot 38 \times 120 \times 80}{1560} = 390 \times 2 = 780$ tons, the breaking weight of the bridge in the middle, or 1560 tons equally distributed over the surface of the platform of the bridge.

From this it will be observed, that after deducting the permanent load of the Torksey bridge (177 tons), there remain 1383 tons, as resisting force to the travelling load of 195 tons, which, according to calculation, is rather more than seven times the greatest weight that can be passed over the bridge,[*] 12 tons per lineal foot being assumed as the measure of the strength of a tubular girder-bridge, for a double line of rails, and which will cover all contingencies, either as regards the weight of the bridge, the permanent load, or the forces by which it may be assailed.

Another subject of importance is the force of impact and the effects of vibration, on bridges of this description; and although it is only recently, that the Author has had the advantage of reference to the highly valuable Report of the Commissioners appointed to Inquire into the Application of Iron to Railway Structures, he is nevertheless of opinion, that the principles upon which he has endeavoured to establish the construction of these particular bridges, ever since their first introduction, is perfectly secure, and may be relied upon as being calculated to meet all the requirements and the conditions of railway traffic.

He cannot agree with the Commissioners in some parts of that

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[*] Since the Table referred to above was completed, and which has been closely adhered to in the calculations of the strengths and proportions of wrought-iron tubular girders during the last 18 months, 1 ton per lineal foot has been taken as the permanent weight of bridges, from 40 feet up to 100 feet span, and the rolling load as 2 tons per lineal foot; and in spans varying from 100 up to 300 feet, the permanent weight of the bridge is estimated at 1½ tons per lineal foot, and the rolling load also at 1½ tons per lineal foot. For practical purposes these proportions are found to be perfectly safe; although in spans above 300 feet, where the permanent weight of the structure becomes a large proportional of the load, it becomes necessary to introduce into the calculation new elements as regards strength, as may be seen in those for the Britannia and Conway Tubular Bridges.

Report, as several of the experiments therein referred to, do not appear to bear out the fact of increased deflection at high velocities. In several carefully conducted experiments on tubular girder-bridges, of spans varying from 60 feet to 100 feet, the deflection was found to be, as nearly as possible, the same at all velocities; and although the experiments at Portsmouth (at some of which the Author was present) are highly valuable, and exceedingly interesting, he is nevertheless of opinion, that there must be a considerable difference in the effects of a weight, rolling over a cast-iron bar, 9 feet long, and that over a bridge 60 feet long. It is true the Commissioners, in their Report, have qualified the results obtained from these experiments, by others made upon existing cast-iron railway girder-bridges, where the deflection was reduced from an increase of the statical deflection, amounting to $\frac{2}{10}$ths of an inch, as produced upon the 9-feet bars, at a velocity of 30 miles an hour, to $\frac{1}{7}$th of an inch upon a bridge of 48 feet span, at a velocity of 50 miles an hour; thus clearly showing, that the larger the bridge, and the greater the rigidity and inertia of the girders, the greater will be the reduction of deflection to the passing load. In the tubular girder-bridges, composed of riveted plates, it must be observed, that the Commissioners had no experience, nor were they acquainted with the strength, rigidity, and other properties of girders, composed of wrought-iron riveted plates. The deflection due to the passing load, appears to be the same at all velocities, and unless there exist irregularities and inequalities on the rails, tending to cause a series of impacts, it may reasonably be concluded, that the deflections are not seriously, if at all, increased at high velocities.

On the effects of impact, the Author perfectly concurs in opinion with the Commissioners, that the deflections produced by the striking body on wrought iron, is nearly as the velocity of impact, and those on cast iron greater in proportion to the velocity.* These experiments and investigations are extremely valuable.

The mode of testing bridges is a part of the inquiry which requires consideration, and in order to maintain unimpaired the elastic powers of the structures, the tests should not exceed the greatest load the bridge is intended to bear at high velocities; in fact, the Commissioners are correct in assuming, that the flexure of the girders should never exceed one-third of their ultimate deflection. In wrought-iron girders, the effects of reiterated flexure are considerably less, in a well-constructed bridge, of similar proportions to those given in the table, than those of cast iron. The deflection produced in these constructions, by the greatest load, will not be more than one-sixth of the ultimate flexure of the girder. On this subject, the effects of impact and the resistance of tubular girders to a rolling load, were strikingly exhibited, in the experimental tests made on the first construction of this kind, erected for carrying the Blackburn and Bolton Railway across the Liverpool and Leeds Canal, at Blackburn.

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* *Vide* Report of the Commissioners appointed to Inquire into the Application of Iron to Railway Structures. Folio. Plates. London, 1849.

That bridge is 60 feet clear span, and three locomotives, each weighing 20 tons, coupled together, so as to occupy the entire span, were made to pass over, at velocities varying from 5 miles to 20 miles an hour, producing a deflection, in the centre of the bridge, of only $\frac{3}{16}$ths of an inch. Two long wedges, 1 inch in thickness, were then placed upon the rails in the centre of the span, and the fall of the engines from this, when at a speed of 8 miles to 10 miles an hour, caused a deflection of only ·420 inch, which was increased to ·54, or about ½ an inch, when wedges 1½ inch in thickness were substituted. These were severe tests, and such as would not be generally recommended, as the enormous strength of these girders is now well understood, and they may safely be considered fit for service, after being subjected to the heaviest rolling load, or one-sixth of the breaking weight, taken at high velocities.

The paper is illustrated by a model and by diagrams, showing the construction and dimensions of the bridge, from which Plate 11 has been compiled.

Previous to commencing the discussion on the paper,—

Mr. C. Manby, *Secretary*, stated, that the subject of the Torksey Bridge had already been twice brought before the Institution; first, at the meeting of January 29, 1850, when Mr. J. Scott Russell begged to detain the meeting for a few minutes, for the consideration of a question of considerable importance to the profession.

The Royal Charter stated the Institution to have been incorporated, "for the general advancement of mechanical science, and "more especially for promoting the acquisition of that species of "knowledge which constitutes the profession of a civil engineer." It was generally considered, that any question vitally affecting the interests, or professional dignity of Civil Engineers, could not be submitted to a better tribunal than that of the Council of the Institution; to that body, therefore, he would, in the name of a large number of professional brethren, address himself.

It was well known, that for some time past there had been many attempts to restrict the free exercise of the talent and ingenuity of engineers, and to interfere with the progress of mechanical and constructive science, by the establishment of Government Boards and Commissions; almost, in fact, endeavouring to introduce a system analogous to that of the Ingénieurs des Ponts et Chaussées, which had proved so detrimental to all individual enterprise in France. In the year 1847, a Royal Commission was appointed, for inquiring into the application of iron, in structures exposed to violent concussions and vibration; the Report of that Commission had recently been made public;[*] it expressly stated, that "considering the great importance of leaving the genius of scientific men unfettered, for the development of a subject, as yet so novel and so rapidly progressive as the construction of railways, we are of opinion, that any legislative enactments with respect to the forms and proportions of the iron structures employed therein, would be highly inexpedient." Relative to the forms of construction of hollow girders of wrought iron it was also stated, "those methods appear to possess and to promise many advantages, but they are of such recent introduction that no experience has yet been acquired of their powers to resist the various actions of sudden changes of temperature, &c."—"For the reasons above stated we are unable to express any opinion upon them." Almost simultaneously, however, with the issuing of this Report, a girder bridge, built of wrought iron, from the designs and under the superintendence of an engineer of admitted skill and extensive practice, was declared by one of the Inspecting Officers of the Railway Board, to be unfit for the public service, because it did not conform to the rules, which, in the Report of the Commissioners, were expressly declared to be applicable to cast iron only. The actual consequence of this decision, or rather of this application of an antiquated formula to a modern invention, was, that the public had already been for one month deprived of the use of an important line of railway, and the probable consequence was the condemnation of the majority of the railway girder-bridges, which had for years borne with safety the greatest loads that could be imposed on them, under any circumstances of their traffic, and the possible result might be, the rejection of that magnificent monument of engineering skill, the Britannia Bridge.

It was for the public to decide, how long the communications of the country should be interrupted, and the invested capital remain unproductive; but it was for civil engineers to consider whether their reputation should lie under the ban of professional incompetency, because an officer acting under Parliamentary authority interfered, by applying an antiquated rule to a new system of construction, for which it had never been intended. It would be easy to show, that if the bridge, to which he alluded, was not strong enough, half the girder bridges, already constructed, were dangerous for the public service, and yet they had for years performed their duty, and exhibited no greater signs of weakness at present, than they did when they were declared by the same Government officer to be perfectly safe, according to Act of Parliament. He must submit, that it was degrading to the profession, that their reputation should be at the mercy of the arbitrary application of legislative enactments, to structures for which the rules were never intended.

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[*] *Vide* Report of the Commissioners appointed to Inquire into the Application of Iron to Railway Structures. Folio. Plates. London, 1849.

In Mr. Scott Russell's own case; he had constructed some wrought iron girder-bridges, of acknowledged correct proportions, and had guaranteed the result; now by the application of this objectionable rule to these girders, they would probably be rejected, and this had been decided on without any notice to the public, to the Railway Boards, or to the engineers, in any way.

Under such circumstances, he would submit, that the body of the profession naturally looked up to the Council for support and aid, in representing, in the proper quarter, the grievous wrong under which they were suffering, and from the high character and standing of the Members of the Council, he was induced to hope confidently, that the appeal would not be made in vain, for their careful consideration of all the circumstances, and their taking such steps as the Charter would permit, and as would appear to be most prudent, and dignified, for relieving the profession from the trammels which were now attempted to be imposed upon its members.

The subject was again formally alluded to at the meeting of February 5th, 1850, when Mr. J. Scott Russell inquired whether any steps had been taken by the Council, in consequence of the statement submitted at the meeting of Tuesday, January 29? He begged to urge the consideration of the manner in which the interests of the public and of the profession, were likely to be affected, by the attitude recently assumed by the Railway Commissioners, in reference to the strength of the wrought-iron girder bridges constructed for railways. It was generally understood, that the excellent Report of the Commissioners for inquiring into the strength of iron structures employed on railways, was intended solely to apply to cast iron and not to wrought iron, and therefore it was essential the question should be set at rest, without further loss of time.

Mr. Vignoles was glad to hear of the probability of the important question of legislative interference being discussed: he had recently experienced the effects of it in a manner which, he must contend, was extremely obnoxious. A large timber bridge, constructed from his designs, at Lancaster, on a curve in plan, and spanning the river at a considerable angle, had been objected to by the Railway Commissioners, in a letter addressed to the Directors of the railway, asking why their engineer had presumed to build such a bridge, without the permission of the Railway Commissioners. Neither the construction, nor the strength of the bridge had ever been questioned, during the eighteen months for which it had been in use; and he submitted, that such gratuitous interference, as that which he described, was unwarranted, and he did not feel inclined to submit to such dictation from any Government Board.

Captain **W. S. Moorsom** suggested, that as many engineers must have found themselves in similar positions, with respect to the Railway Commissioners, it would be advantageous to address full particulars of all such cases to the Secretary of the Institution, for the guidance of the profession, or for discussion at the meetings, according to the nature of the case.

Mr. J. Simpson, *V.P.*, stated, that the Council had not, as yet, taken any decided steps in the matter, but that a course had been suggested, which, it was expected, would lead to satisfactory results. He begged the Members to transmit to the Secretary, as Captain Moorsom had suggested, all the information in their possession, as to cases of legislative interference with engineering constructions.

Mr. J. Scott Russell expressed himself satisfied with this assurance; and, in the full confidence of the interests of the profession being quite safe in the hands of the Council, by whom, he was certain, everything would be done for insuring the position and professional reputation of the Members, he begged to withdraw the motion he had prepared.

After this recapitulation of the previous proceedings,—

Mr. Fowler directed attention to a model of the Torksey Bridge, with a large drawing of a transverse section (Plate 11) of the bridge, at the centre, and a diagram* (Fig. 3, page 25), exhibiting the result of a series of experiments for the purpose of showing the effect of a load upon the girders, when they were, as in this case, united over the centre pier; or, in other words, when each continuous girder was considered as covering two openings, formed by the centre support.

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* *Vide* Note, page 28.

He was much indebted to Mr. Fairbairn for pronouncing the bridge to be of sufficient strength; but the investigation would have been more satisfactory, if the structure had been viewed as composed of continuous girders, each stretching the full length of the platform, and resting upon the three points; this would be found to add one-fourth to the absolute strength of the part of the girder spanning each opening.

The diagram (Fig. 3, page 25) had been prepared for the purpose of showing the effect of the continuity of the girder, the dotted line showing the curve of deflection, due to weighting the two openings equally with the weight of the structure itself alone; the full line showing the deflection, due to an additional load of two trains of locomotives upon one span. The latter experiment proved, that the distance from the point of contrary flexure to the centre pier was less than 25 feet, causing a practical reduction of the span from 130 feet to about 105 feet, and adding at least one-fourth to the strength of the bridge. Now any principle that added one-fourth to the strength of a bridge was, he considered, too important to be so lightly passed over; added to which, he thought the saving of cost in the construction of the work was an important additional consideration.

He thought there was an error in the computation of the proportion between the bottom and the top of the girder, as it would appear, that the area of the rivet-holes had not been deducted from the former, which should evidently have been done. Now the gross sectional area of the bottom being 54·93, and the rivet-holes diminishing the area full 5·25, an area of 49·68 would be left, making the proportion of 51 to 49·68, which corresponded very nearly with the proportion of 12 to 11 given in the paper.

In building the first of these girder bridges (the subject being new to him), Mr. Fowler had been guided by Mr. Fairbairn's proportions, as he was the constructor of the girders; and it did appear extraordinary, that the dimensions of a bridge of 95 feet span, which had now been open for traffic for full two years, differed materially from the dimensions given in the paper. Now as that bridge had performed its duty efficiently for two years, it would be interesting to learn why Mr. Fairbairn had changed his views as to the requisite dimensions, and why that proportion of the depth to the span, which at so recent a period had been considered sufficient, should now be deemed insufficient.

The drawing represented the strength of one girder calculated according to Mr. Fairbairn's proportion and formula; therefore the total strength of the two would be equal to 1560 tons. The bridge had been tested by placing six locomotive engines, weighing together 222 tons, on one opening, occupying the whole extent of it, which, of course, was a greater test than if a similar weight had been placed at the same time on the other opening, as, in the latter case, one load would have balanced the other. The effect of placing six heavy engines in that situation was to cause a deflection of 1¼ inch, and on the removal of the load, the platform of the bridge immediately returned to its original level. Great care was taken to ascertain if the main beams had any tendency to approach each other, with that weight resting on them, but there was no indication of such a change of form.

Mr. BIDDER said, the Torksey Bridge had excited the attention of the profession, from the fact of the Commissioners of Railways having objected to the opening of the bridge for traffic, on the plea of care for the safety of the public. Mr. Fowler had requested him, with other engineers, to examine the structure, in order to give an opinion as to whether the strength of the bridge was sufficient, and if not, to point out where it required strengthening. After careful inspection and consideration, the general opinion arrived at was, that the bridge was sufficiently strong for all practical purposes of public safety. So far as he could gather from the paper, that also appeared to be Mr. Fairbairn's opinion, although he had detracted from the value and weight of that opinion, by assigning other proportions to a bridge of those dimensions. As, however, the principles which had guided Mr. Fairbairn in his calculations were so entirely different from those Mr. Bidder had adopted for ascertaining the strength of girder bridges, he thought it was only right to state what he believed to be the correct principle. If right, he should have done some service in laying his views before the Institution; and, if wrong, he should have the advantage of being corrected.

The first point to which Mr. Fairbairn had directed attention, was the relative areas of the top and bottom of the girders, and he had stated, that the proportions between them should be in the ratio of 11 to 12, and that any excess of those proportions was so much dead weight uselessly employed; that is to say, if the 12 was increased to 13, it was so much weight added, without imparting any corresponding strength. Mr. Bidder thought that must be erroneous, because, in the tabular statement, instead of those proportions of 11 to 12 being rigidly adhered to, the ratio of 12 to 14 was occasionally adopted. He also believed Mr. Fairbairn was in error, in saying that the increase in dimensions over any assumed ratio was an addition to the weight of the bridge, without being any addition to its strength. The top of the bridge was exposed to compression, and the bottom to tension: between those two there existed the neutral axis; therefore, the compressing force on the one, and the tensile strength on the other, must be equal; the result must then be, that any addition to the bottom only removed the neutral axis so much further from the top, bringing it so much nearer to the bottom: it was true that it might not gain all the advantage of that addition of metal to the bottom, but it was certain that some additional strength was obtained. Supposing the top and bottom to be in the proportion of 11 to 12, the paper implied, that if 11 was added to the bottom, making it 22, no strength would be added to the bridge, but that it would be encumbered by an extra weight of metal. Mr. Bidder denied that position, and thought that, the neutral axis being removed from the top, by any addition of metal to the bottom, even if that addition amounted to 34, the strength of the bridge would be increased by one-third; adding 50 per cent. in weight, and gaining 30 per cent. in strength. He did not mean to say that would be a judicious distribution of the metal, but he thought it wrong to suppose it would perform no duty, and much less that it would be injurious. He thought it incorrect to fix any arbitrary limits to two quantities increasing in different ratios, and in that respect he was decidedly at issue with the deductions of the paper.

He also dissented from the notion, that the depth of a girder should be restricted within any given limits; in practice, engineers were scarcely ever able to fix such limits, being generally guided by local considerations. The question of the proper depth of a girder, was at present entirely unascertained, and it was clear the Author of the paper could not have arrived at any precise notion on the subject, because the original table sent with the paper assigned the proportion of $\frac{1}{18}$th of the span for the depth of a girder of any span, but in the amended table, subsequently transmitted, that proportion was only retained up to spans of 150 feet, and the proportion of $\frac{1}{15}$th was adopted for all greater spans.

Theoretically, the top and bottom could not be placed too far apart; in practice, the consideration was, the least amount of metal that would enable the top and bottom to be placed at a proper distance to prevent the sides from buckling. That was a question which could not be decided mathematically, but must be determined entirely by experiment. He was not aware what reasons had induced this alteration of the table, within the last fortnight; but he thought it would not be wise to adopt blindly any empirical limit. He thought it a mistake, to endeavour to ascertain the strength of a girder by finding the greatest weight it would sustain, and he was not aware of any received coefficient, so large as 20 tons to the square inch; the largest he knew of was 16 tons.

He agreed in the observations on the small effect of vibration, by railway trains, passing over bridges; he believed it to be a mere ghost, raised by mathematicians to frighten engineers as to the strength of their structures, and he thought the engineers were bound, as standing between the mathematicians and the public, to apply to their deductions the principles of common sense. When once a certain length of girder was exceeded, the effect of concussion ought to be left entirely out of consideration. Mr. Fowler had placed on his bridge an extraordinary weight of 222 tons on one opening, and it was asked, what would be the effect of that weight in motion, treating it as 222 tons on one pair of wheels, propelled in a given direction; it must be remembered, that weight would be distributed over 72 wheels, each having a spring, and as that weight could only operate on a girder through the instrumentality of the rails, which were nearly 6 inches in depth by 1 inch in thickness, it would be seen that the effect, whether vertically, or laterally, would be absolutely nothing on a structure of that weight and rigidity. The fracture of a rail, or a chair, laterally, by the action of a train, was a thing of rare occurrence, except when the carriages got off the line; as an engineer, he considered, practically, that might be omitted from consideration. It must then be supposed, that the strain would act vertically and snap the girder; but there was not a rail which was not subjected, by every train passing over it, to a much greater strain than any on the bridge in question. In his opinion, the effect of concussion on any bridge of such a span, with girders of such dimensions, was a matter unworthy of notice.

In making a few observations, for the purpose of showing that the bridge, as constructed by Mr. Fowler, and so retained, in opposition to the report of the Inspecting Officer, was abundantly strong, he desired it might not be supposed that he wished to reflect on that gentleman, who had never shown the slightest desire to throw impediments in the way of any engineer, or that he should be supposed to wish to do more, than to have the question fairly and honestly discussed before the Institution. Captain Simmons had stated in his report, that he should be satisfied, if one opening of the bridge would sustain a load of 400 tons, with a strain of 5 tons to the inch, the dead weight of the bridge being 175 tons, leaving 225 tons for the rolling load. In order to submit it to a severe test, Mr. Fowler had placed 222 tons on one opening, but he would ask, under what circumstances of ordinary traffic was the bridge liable to be exposed to that test? It could only be on the supposition of three coupled engines travelling on each line, without any carriage being attached to them, and meeting on one particular opening. In practice, three coupled engines were not often attached to a heavy goods train, and it was not probable that three engines would often go out alone. The supposed test, however, required the same weight on both lines; it might be fairly presumed, that one of the sets of engines would have a train attached to it, and resting on the other opening; so that the effect would be diminished on the portion on which the engines rested. After subjecting the bridge to that weight of 222 tons, the deflection was ascertained to be 1½ inch. Captain Simmons said, if it would bear that weight and not have more strain than 5 tons on the inch, he would be satisfied; whatever extent of weight that was derived from, the effect on the tension of the iron would be the same, and taking the strain on the bottom to be 5 tons to the inch, the deflection ought to be 2 inches; it was actually only 1½ inch, therefore the experiment proved the strain was not 5 tons to the inch. Mr. Bidder had not been quite satisfied on that point, until Mr. Wild's experiments, on a similarly proportioned beam, showed the point of bearing was practically reduced from 130 feet to 105 feet, by the continuity of the tubes, over the centre pier, by which the length of the girder, exposed to strain, was not only reduced, but the weight being equally diffused, was also diminished, and therefore the deflection would be reduced as the square; this induced the conclusion in his mind, that the Torksey bridge was abundantly strong for all purposes of public safety.

Mr. EATON HODGKINSON said, it was with great reluctance that he made any observation in the absence of Mr. Fairbairn, differing as he did from him in many of his conclusions. Mr. Fairbairn had in his paper adduced a formula, with a coefficient attached, for the strength of wrought-iron tubes; but the adequacy of that formula might be questioned; indeed if the tubes were made as proposed in the paper, it was doubtful whether it might not be unsafe and dangerous, to rely upon the formula.

When Mr. Hodgkinson made experiments, many years ago, to ascertain the strength and best form of cast-iron beams, he used the same simple formula, with a coefficient deduced from numerous practical experiments on the fracture of cast-iron beams. This formula depended merely on the tensile strength of the bottom rib, and on the depth and length of the beam. These data he considered sufficient, for that material; for in cast-iron beams, of the best form, there would be more than twice as much metal in the bottom flange as in all the rest of the beam in the middle.*

This was not the case with the new tubular girders. The defective elasticity of cast iron, rendered it difficult to draw such precise conclusions from it, as from a material of more perfect elastic force, such as wrought iron.

The formula he had found suitable for cast-iron beams, would not, he conceived, be applicable to tubes of wrought iron, where the bottom (whose tensile force was alone included) bore but a small proportion to the whole sectional area; and the sides of the tubes had as much sectional area in them, as all the rest.

The side plates themselves, without the angle-irons to stiffen them, might be equal, at least in sectional area, to the plates in the top and bottom; and to employ a formula that would reject half the material in the tube, because the estimation of its forces could not be easily arrived at, by a simple arithmetical computation only, was not in accordance with the knowledge of the present day.

It might, however, be said, that the formula was applicable to similar tubes, of a particular form; but the tubes in Mr. Fairbairn's table were not similar, and its applicability to tubes of the various kinds in the table was doubtful; and especially to tubes of other forms, as that of the Torksey bridge, the strength of which Mr. Fairbairn had computed by it.

The complete solution, for the strength of tubes in general, was more troublesome than difficult.

If, for instance, the top and the bottom of the tube differed from each other in sectional area, or in form, it would be necessary, first, to obtain the situation of the neutral line, and this would be in the centre of gravity of the section. Secondly, it would be necessary to find the moments of the forces exerted by each of the plates, in the top, bottom, and sides of the tube; or, in other words, the forces of the particles of each, multiplied by their distance from the neutral line. The sum of these moments must be equated, to that from the weight laid on, and the leverage from the length of the tube, between the supports.

Then, for the strength of the tube of the second form, the formula

$$W = \frac{2f(b\,d^3 - b'\,d'^3)}{3\,l\,d},$$

would apply, where d, d', were the external and internal depths respectively, b, b', the external and internal breadths, l the distance between the supports, f the strain per square inch of section, sustained at the top and bottom of the tube, and W the weight, which being laid on the middle of the tube, would produce that strain.*

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* In the strongest cast-iron beam, as obtained from these experiments, the area of the sections of the top and bottom ribs, in the middle, was as 1 to 6 nearly; and the bottom rib had 2·4 times as much in its section, as all the rest.

If f be taken at eight tons per square inch, it would be within the elastic force of the material: some tubes of simple plates had borne as much as double that pressure, or more.

Mr. Fairbairn asserted, that the comparative thickness of the top and the bottom of a tube, should be as 12 to 11, this having been the case in the large tube made in London; but Mr. Hodgkinson contended, that there could be no constant proportion between the thickness of the top and of the bottom. A tube of one thickness of metal might be well proportioned, but double the thickness would render it very much out of proportion. The resistance of thin plates to a crushing force, applied in the direction of their length, was found to vary nearly as the cube of the thickness. Doubling

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* For the manner of computing the strength of the Conway Tube, *see* Appendix, by Mr. Hodgkinson, in the Report of the Commissioners on the Strength of Iron, pp. 174, 175.

In tubes formed of simple plates, with cells at the top, as in those made by Mr. Fairbairn, the section of the top and bottom being nearly equal, the strength might be computed, by assuming another form, of nearly equal strength, and easily calculable, in the following manner:—

Fig. 1.

Section of Tube as formed.

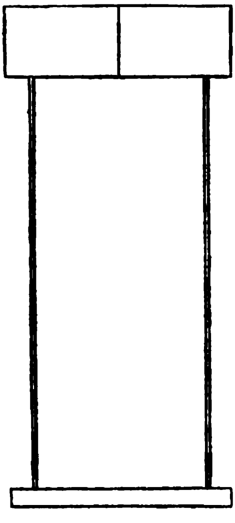
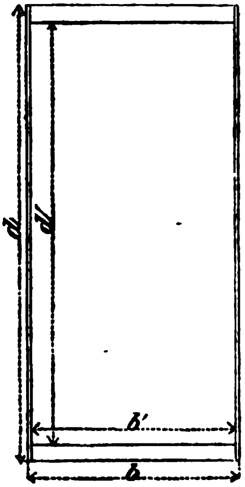


Fig. 2.

Section of Tube nearly equivalent in strength, the thickness of the bottom and sides being equal to those in the former; and the top of equal area of section to that of the cells in the former, and placed at the height of the centre of gravity of the cells.



the thickness of a very thin tube at the top would give six, or seven times the resisting power there; whilst doubling it at the bottom only gave twice the strength. This property of compression, extended only to plates of tubes not strained to more than about nine tons per square inch: it was not easy to give proper proportions for these kinds of tubes, without further practical information. Mr. Hodgkinson had made many experiments, which were given in the Report of the Commissioners, in order to supply that information; but the inquiry was still in its infancy. Empirical laws might by degrees be laid down; but real elementary calculations should, at present, alone be attempted; and these principles, when in practice the plates were thick enough not to buckle by the compression, had long been understood.*

From experiments on the resisting powers of rectangular cells of wrought iron, 4 inches, and 8 inches square, and 10 feet long, compressed in the direction of their length, the thickness and crushing weights per square inch were—

Cells 4 inches square.		*Cells 8 inches square.*	
Inches.	Tons.	Inches.	Tons.
·03	5 nearly	·06	5·9 nearly
·06	8·6 „	·139	9· „
·083	11 „	·219	11·5 „
·134	10 „	·24	Not crushed with 12 tons

These experiments, so far as they extended, showed the weakness of cells with thin plates; and rendered it probable, that the thickness of the plates should be in proportion to the lateral dimensions of the cell.

The practical use of cells in the top of the tube girders, was to prevent the plates from becoming crippled, or wrinkled in that spot; but this would be better done by thick plates, than by rectangular cells, which, in Mr. Hodgkinson's experiments, were generally crushed with a pressure of 12 tons per square inch of section, or even less.

A rectangular tube of great thickness, nearly 7 tons weight, 47 feet long, 45 feet span, 3 feet deep, and 2 feet wide, made of plates ¾ths inch thick, at the top, bottom, and sides, when bent transversely by a load in the middle, was not perceptibly crushed at the top, with a pressure of 12 tons, or 15 tons, per square inch of section; and it required upwards of 17 tons to produce any indication of wrinkling in the top.

The same tube, when its top and bottom plates, in the middle, were replaced with others of the same thickness, and its side plates were made of half the thickness, or ⅜ths inch thick, was not corrugated, or wrinkled in the top, though it was considerably shortened, by the compression there, and had taken a deflexion of 7·33 inches, with a load of nearly 103 tons, in the centre, and a pressure in the top plates of 18 tons per square inch of section. Tubes of half that thickness at the top would probably have wrinkled with a few tons per square inch of section there.

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* *Vide* Appendix to Report of the Commissioners on Iron Beams, page 116.

These facts showed the great importance of increasing the thickness of the plates of tubes; and his experiments rendered it evident, that square cellular tops might be advantageously dispensed with, by increasing the thickness of the plates on the top, by riveting them together, and thus placing the resisting forces at the top and bottom of the tube as far asunder as possible. If, also, in addition, longitudinal ribs of cast iron were riveted to the plates along the top, to resist compression, when the wrought iron failed, a great increase of strength would thus be obtained, as had been shown by his experiments.

Mr. C. H. Wild begged first to read the following extract from the second report by Capt. Simmons, the Government Inspector:—

"In reply to the question, 'Whether if I still remain of opinion that this viaduct cannot be opened with safety to the public, what further strengthening will be necessary?' I have to state that for reasons before adduced, I do not consider, that the viaduct can be opened for the continuous passage of trains, with safety to the public, and that it will not be in a condition to be opened, until it shall have been so strengthened, that a load of about 400 tons, (including the weight of the beams themselves, and all the standing parts of the bridge), distributed equally over the platform of one span, shall not produce a greater pressure upon the top plate of the girders, than five tons per square inch."

In consequence of this opinion, Mr. Wild had, at the request of Mr. Fowler, entered into calculations, to ascertain what the compressive strain on the top of the bridge would be, under the prescribed conditions, when it was found, that it would be less than 5 tons per square inch, the limit defined in the report. As this result differed from that arrived at by the Government Inspector, recourse was had to experiments to confirm the truth of the calculations.

Among the many points noticed in Mr. Fairbairn's paper, was one which he must consider not only unphilosophical, but positively dangerous. The paper said, "It is considered by some engineers, as very important to the strength of these bridges, that the girders should be continuous, or extending over two, or more spans. This is, no doubt, correct to a certain extent, and although the fact is admitted, yet this consideration is purposely neglected, in these calculations; any auxiliary support of that kind acting merely as a counterpoise. It is considered safer to treat the subject on the principle of compassing each of the spans with simple and perfectly independent girders."*

The importance of the effect of continuity was acknowledged by all authorities, so that it could not be admitted, that this was an element, the consideration of which might, with any propriety, be neglected. The Torksey bridge consisted of two openings, each of 130 feet; the two being spanned by a continuous girder resting on the central support. If such a beam was placed on the three supports A, B, C (Fig. 3), and were loaded uniformly, it would assume the shape of the dotted line A *m* B *n* C. It was evident that between A and *m*, the upper portion of the beam would be compressed, whilst in the part *m n*, over the support, the reverse effect would be produced; the beam might therefore be divided into three parts. At the point of contrary flexure, *m*, all horizontal forces ceased, and there existed merely the vertical strain, due to the suspension, at that point, of half the weight of the beam A *m*. If the continuous beam were hinged at the points of contrary flexure, and so divided into three independent beams, the previously existing conditions would remain unaltered. This being the case, it would be an evident error, if in calculating the strength of such a beam, A B only were taken as its length. In order to check, practically, the calculated position of the point of contrary flexure, the experiment was tried on a large wooden model, by loading it, first with such weights as represented the constant load due to the structure. The model beam then took the form shown by the dotted line in Fig. 3, and the point of contrary flexure was found to be 30⅜ inches from the point B. The model was then severed and hinged at that point, when the curve and the deflection were found, as might have been expected, the same as before. In order to ascertain the point of contrary flexure in a beam loaded as prescribed by the Government Inspector, over one span only, an additional weight was added, having to the weight previously applied on that span, the same proportion as 400 tons, the prescribed load, had to 150 tons, the weight of the structure; the point of contrary flexure then approached to within 21¾ inches of the central support. The beam was again severed and hinged at that point, and the curve was formed as regularly as before, the deflection on the heavily-loaded side being 5⅛ inches. The beam was then cut in half, making it into two detached beams, the ends

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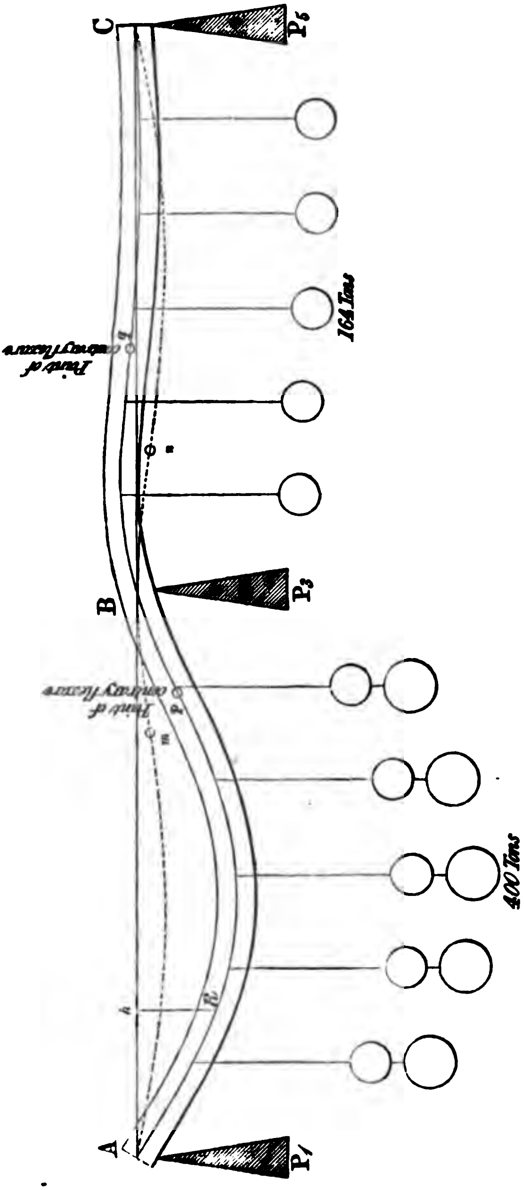
* *Vide* ante, page 6.

Fig. 3.

Diagram of Deflection.



The dotted line represents the position of the girder as deflected by its own weight only, viz., 164 tons distributed over each span.

meeting on the central pier, when it was found on the heavily-loaded side that the deflection was increased to 9¾ inches. As much weight was then removed, as reduced the deflection to the same amount as had, in the continuous beam, been produced by the weight representing 400 tons, and the proportion borne by the weight requisite to produce a given deflection in the detached beam, was to that requisite to produce the same deflection in the continuous beam as 65½ to 120. Having found the position of the point of contrary flexure in a beam, loaded in the proportions prescribed by the Government Inspector, it was easy to calculate the strain upon the top cells of the Torksey bridge. The virtual length of the girders would be 130—21¾ = 108¼ feet: the load upon these girders would be, $\frac{108\frac{1}{4}}{130} \times 400 = 333$ tons, or upon each girder 166 tons, or upon the centre 83 tons. If, for the sake of simplicity, the value of the side plates was omitted, the strain upon the top cell would be—

$$83 \times \frac{108\frac{1}{4}}{4 \times 9 \cdot 5} \times \frac{1}{50} = 4 \cdot 67 \text{ tons per inch ;}$$

being less than the limiting strain of 5 tons per inch, defined by the Government Inspector.

The experiments, therefore, fully corroborated the truth of the calculations previously made, and showed the compressive strain per square inch, on the top cell of the girder, to be less than that for exceeding which the Government Inspector had condemned the bridge, and thus an important line had remained for some considerable period closed at a great pecuniary sacrifice, the Railway Company had been, and were still deprived of the use of their property, and the public convenience suffered, not in consequence of any omission on the part of the engineer to provide adequate strength for the public security, but from the pernicious effects of Government interference, and from the necessary consequence of the want of practical skill, always demonstrated when officers whose duties were strictly military were entrusted with the control of civil works.

Mr. Pole said he had been requested by Mr. Fowler to examine the questions of the strength and deflexion of the Torksey bridge, and he begged permission to read to the meeting the results of his investigations, as they would appear clearer than by merely speaking on the subject.

He then, by permission of the President, read as follows :—

"In a case of so much importance as that now under discussion, it appears desirable to apply rules of calculation more extended than the simple one used by Mr. Fairbairn. In order to form a correct judgment on the question, it is necessary not merely to obtain a general approximate notion of the strength of the bridge, but to ascertain, with all possible exactness, the nature and amount of the strains to which the structure is exposed; and this can only be done by a comprehensive process of calculation, which, though more laborious, will be more satisfactory.

"As no doubt appears to be raised as to the sufficiency of the transverse bearers supporting the platform, the only question is, as to the strength of the main wrought-iron tubular girders extending across the stream, and to this alone, therefore, attention need be directed.

"The problem for determining the strength of a beam, resolves itself, in this case, as in many others, into the following question—'When a certain beam is loaded with a given weight, what is the greatest longitudinal strain, either of extension, or compression, on any of its fibres?' It is well known, that when an elastic beam, supported at both ends, is weighted in the centre, the upper fibres of the beam are compressed and the lower fibres extended. Now, it has been well ascertained what degree of longitudinal strain may be applied to these fibres with safety; and therefore, if the ratio can be established, which exists between the weight a girder is supporting, and the compressive or tensile forces on its top and bottom plates, we have effectively determined the question, whether such girder is, or is not, sufficiently strong. For example, Mr. Hodgkinson states, in his calculations on the Britannia and Conway tubular bridges, (Report to the Iron Commission, pp. 171 and 178), that the metal of the tubes may be allowed to bear, at a maximum, 8 tons per square inch compressive strain, and about 10 tons tensile strain; the ultimate strength in each case being about half as much more. Now, if we can show, that in the Torksey bridge girders, when loaded to the utmost, the greatest compressive strain is little more than half 8 tons, and the greatest tensile strain less than half 10 tons, we establish, to all intents and purposes, the sufficient strength of the bridge.

"The general rules for determining the strains on beams of a perfectly elastic material (as wrought iron may be assumed to be), are well established, and very generally known; but in attempting to apply them to the Torksey bridge, we are met at the outset by a peculiarity in the case, which throws some difficulty in the way.

"Each girder, instead of extending over one span only, is of double length, being continued over the two openings, and being supported at three points A, B, and C, as shown in Fig. 3, page 25. Now, it must be apparent, almost at first sight, that this continuity will increase the strength of the girder, as far as one opening is concerned; but the degree in which the strength is thus increased, does not appear hitherto to have been fully appreciated. It has been usual to estimate the strength of the girder as if extending over one opening only, assuming that the continuity, though somewhat of an improvement, is scarcely worth bestowing much thought upon. This, however, is but an unsatisfactory mode of dismissing the subject; if it be an improvement at all, its value should be determined, if not, its uselessness should be proved.

"Suppose the half of the bridge A B to be loaded with the greatest weight which can be put upon it, and which, including the weight of the structure itself, may be taken at 400 tons: and let the other half B C have nothing upon it but the weight of the structure, which is 164 tons; both these loads being uniformly distributed over their respective spans. This is the loading defined as the test of the bridge.

"The problem then to be solved is — What is the strain on the girder, compared with what it would be if the said girder extended only over the span A B, without being continued over the adjoining opening?

"It does not appear, that any writers on the strength of beams have investigated this case. Professor Moseley, in his 'Mechanical Principles of Engineering,' has discussed two cases somewhat similar, viz., one where a load is distributed equally over the two openings, the same on each; and another where unequal weights are hung from their centres.*

"It is not difficult, however, to apply mathematical investigation to the case in point, and formulæ may be obtained, by which the line of deflection can be calculated for the entire length of the girder; and by these formulæ, the lines upon the diagram, Fig. 3,† have been laid down. The *dotted line* represents the form the girder should take when acted upon by the weight of the structure only; the *black line* shows the form it should take, when one opening is weighted as before mentioned; the deflexions being, of course, very much magnified. Following the black line from the point A, it will be perceived, that the curve at first assumes a shape concave upwards (similar to the usual deflexion curve), which it retains as far as a certain point *p*, marked 'point of contrary flexure.' Here the curvature is reversed, the upper side becoming convex, and this continues as far as another 'point of contrary flexure' *q*, on the other side of the centre pier, where the curvature again takes its original form, to the end of the beam. It is to these two 'points of contrary flexure' that attention should be directed, as their position solves the problem.

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* *Vide* Moseley's Mechanical Principles of Engineering and Architecture, pp. 519 and 521, Arts. 377 and 379.

† Two diagrams were exhibited at the meeting, one laid down from the experiments of Mr. Wild, the other from the calculations made by Mr. Pole, as stated above; but the lines of the curves were so nearly identical, that one figure has been considered sufficient for both cases.—*Sec. Inst. C. E.*

"The curve being concave from A to *p*, the upper fibres will be compressed, and the lower ones extended; but beyond this point, these strains will be reversed, the upper fibres will suffer extension, and the lower ones compression. Now, it must be evident, that at the point where this reversion of the strains takes place, that is, at the point of contrary flexure, the fibres will be in their normal condition, they will be neither compressed, nor extended, nor will there be any longitudinal strain upon them. It is evident, therefore, that this point of the beam is in the same condition as one of the ends A, or C, and, in fact, the beam might be sawn through here, without at all affecting the equilibrium of the structure, provided that this end was merely hooked up to, or hung from, the part adjoining. Indeed, this was practically demonstrated by Mr. Wild's experiments, where a model beam, weighted and deflected as shown in the figure, was actually cut through at this point of contrary flexure, and a thin lamina removed, yet the beam retained its equilibrium perfectly, and no tendency to longitudinal strain was exhibited at the point of section. Very little consideration will suffice to show, that in no other point of the beam, except where the curves change, could this be done, without destroying the equilibrium of the whole.

"Since, therefore, the two points of contrary flexure are in the same condition as if they formed ends of beams, it becomes clear that the effect of the continuity of the girder is to distribute the load over three bearing lengths instead of two, which may be considered, as in Mr. Wild's experiment they really were, three distinct and separate beams; the first from A to *p*, the second from *p* to *q*, the third from *q* to C.

"The first beam is supported at one end by the pier A, while the other end hangs on the end of the middle beam. The beam at the opposite end is supported in like manner, and the middle beam is in equilibrium, like a common lever, on the centre pier B.

"We may dismiss the two latter-named beams without further notice, and confine our attention to the first beam, which is the one most exposed to danger. One end of this is, as already stated, supported on the pier A, the other hangs at *p*, to the end of the centre beam. This is, in effect, the same thing as if the beam was supported at both ends, and thus we have the common problem of a simple girder supported at both ends, and loaded with a weight distributed over its whole length; this beam being, however (for this is the important point), considerably shorter than the span of one opening of the bridge.

"Now, this difference of length, or, in other words, the distance of the point of contrary flexure from the centre pier, is determined by the mathematical investigation already alluded to;—for the loads above given, it comes out something less than 23 feet, leaving 107 feet for the effective length of the beam. The value of the advantage gained by the continuity of the girder is thus apparent; for, instead of a girder 130 feet long, bearing 400 tons, we have, effectively, a girder only 107 feet long, bearing 330 tons; giving an increase of strength of rather more than one-third.

"The remainder of the calculation, necessary to determine the greatest longitudinal strain on the fibres of this beam, is very simple, and follows the ordinary rules.

"The beam is supposed to be perfectly elastic, and the neutral line is found according to the well-known proposition, that in such a beam it will pass through the centre of gravity of the section. This brings it 56 inches from the bottom, or 64 inches from the top, of the girder.

"The moments of the strains on each part of the section (omitting the rivets and angle-irons at the bottom), are then taken round the neutral line, and by equating these, in the ordinary manner, with the moments of the load on the beam, we obtain:—

The greatest compressive strain on the top-plates of the girder, with a load of 400 tons	= 4·55 tons per sq. in.
The greatest tensile strain on the bottom-plates	= 4·00 „ „ „

"It is remarkable, how closely the results obtained by Mr. Wild's experiments agree with the results of the mathematical investigation, the general form of the deflexion curve being nearly identical in both cases, although the two classes of results were obtained entirely independent of, and uninfluenced by each other.

"The experimental distance of the point of contrary flexure, where the model beam was cut across, from the centre pier, is a little less than 22 feet; as calculated, it is 22 feet 11 inches. For the unloaded beam, the calculation gives the distance of this point = 32 feet 6 inches; the experiment = 30 feet 6 inches. The experiment gives the greatest compressive strain = 4·67 tons; the calculation = 4·55 tons.

The deflection of the bridge is, to what it would be, if the girder extended over one span only, by calculation, as 100 to 170, whilst by experiment it is found to be as 100 to 180.

"The deflection of the bridge due to the rolling load, comes out by calculation $1\frac{1}{16}$ inch; and when the bridge was loaded with locomotive engines, the actual deflexion was found to be about $1\frac{1}{4}$ inch.

"The most important result, however, is that already given in reference to the strain, as this applies directly to the question of the strength of the bridge. If the experiments and calculations are to be relied upon, they prove, that when the bridge is loaded with the defined test weight, the utmost compressive strain on the plates of the girders is less than 5 tons per square inch, and the utmost tensile strain only about 4 tons per square inch.

"Let these results, therefore, be compared with the statements of the best authorities, that a compressive strain of 8 tons, and a tensile strain of 10 tons, may be borne without danger, and the question is at once decided, whether or not the Torksey bridge is sufficiently strong."

The following are the calculations alluded to in the foregoing remarks:—

Investigation of general formulæ applicable to the Torksey Bridge.[*]

A beam of uniform section, and of perfectly elastic material, is supported horizontally at three points, A, B, and C (Fig. 3, page 25), the support B being midway between the two others. The two spans, A B, and B C, are each loaded with different weights, distributed uniformly over the length of each span respectively, the weight on the part A B being greatest.

To determine the deflexion curve of the beam, and the strength of the part A B,

Let l = A B, or B C = the length of each opening.

μ = weight per lineal unit distributed over the space A B.

μ_2 = ditto over the space B C.

$\left.\begin{matrix}P_1\\P_2\\P_3\end{matrix}\right\}$ = pressures upon the three supports A, B, C, respectively.

x = A h = horizontal distance from A of any point R in the neutral line of the beam.

y = h R = the deflexion at that point.

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[*] A more extended investigation on the subject of continuous beams has been given by the Author of these remarks, in Mr. Edwin Clark's work on the Britannia and Conway Tubular Bridges, which may be referred to for further explanation and application of the mathematical processes here employed.

If R be any point in the neutral line of the beam, whose co-ordinates are x and y, the portion R A of the beam is held in equilibrium by three forces, viz. :—

1st. The pressure, P_1.

2nd. The load on that portion of the beam, $= \mu\, x$.

3rd. The elastic forces called into operation on the transverse section of the beam at R.

The principle of the equality of moments must therefore obtain in reference to these forces; *i. e.*, the sum of the moments of the 2nd and 3rd, which act together to turn the part R A round R in one direction, must be equal to the moment of the first, which tends to turn it in the opposite direction.

Now, 1st. The pressure P_1 acts at a perpendicular distance from $R = x$; therefore the moment of this force is $= P_1 x$.

2nd. The load $\mu\, x$ may be considered as collected at a point distant $\frac{1}{2}\, x$ from R; therefore the moment of this force $= \frac{\mu x^2}{2}$

3rd. Let, for the present, the moment of the elastic forces of the beam round $R = \phi$.

$$\text{Then } \phi + \frac{\mu x^2}{2} = P_1 x.$$

$$\text{(I.)} \qquad \text{or, } \phi = P_1 x - \frac{\mu x^2}{2}.$$

If E represent the *modulus of elasticity* of the beam, and I the moment of inertia of its transverse section round the neutral line, the moment of the elastic forces will be represented by the equation,*

$$\phi = -\mathrm{E\,I}\,\frac{d^2y}{dx^2}.$$

Whence we have

$$\text{(II.)} \qquad \mathrm{E\,I}\,\frac{d^2y}{dx^2} = \frac{\mu x^2}{2} - P_1 x.$$

Integrating this, and representing the inclination to the horizon of the tangent to the neutral line at B, by β, so that at that point, $\frac{dy}{dx} = \tan\beta$, we have

$$\mathrm{EI}\left(\frac{dy}{dx} - \tan\beta\right) = \frac{\mu}{6}\,(x^3 - l^3) - \frac{P_1}{2}\,(x^2 - l^2)$$

Integrating again,

$$\text{(III).} \quad \mathrm{EI}\,(y - x\tan\beta) = \frac{\mu}{6}\left(\frac{x^4}{4} - l^3x\right) - \frac{P_1}{2}\left(\frac{x^3}{3} - l^2x\right)$$

which is the equation to the deflection curve from A to B.

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* For a demonstration of this, *vide* "Britannia and Conway Tubular Bridges." Equation xxxi., page 270.

At the point B, when $x = l$, we know that $y = 0$; therefore, by substituting these values in equation (III.), we obtain,

$$\text{(IV.)} \qquad \text{Tan}\ \beta = \frac{l^2}{24\,\text{EI}}\ (3\,\mu l - 8\,\text{P}_1)$$

Now, by applying a similar process to the part B C of the beam and remembering that the angle β must in this case have a contrary sign, we obtain,

$$\text{(V.)} \qquad \text{Tan}\ \beta = \frac{l^2}{24\,\text{EI}}\ (8\,\text{P}_5 - 3\,\mu_2 l)$$

Comparing this with equation (IV.) we obtain,

$$\text{(VI.)} \qquad 3\,\mu l - 8\,\text{P}_1 = 8\,\text{P}_5 - 3\,\mu_2\,l.$$

By the principle of equality of moments round B, we have

$$\text{(VII.)} \qquad \text{P}_1 l + \frac{\mu_2\,l^2}{2} = \text{P}_5\,l + \frac{\mu\,l^2}{2},$$

whence by substitution with equation (VI.)

$$\text{(VIII.)} \qquad \text{P}_1 = \frac{7\,\mu\,l - \mu_2 l}{16},\ ^{*}\ \text{and}$$

$$\text{(IX.)} \qquad \text{P}_5 = \frac{7\,\mu_2\,l - \mu l}{16},$$

and since $\text{P}_1 + \text{P}_3 + \text{P}_5 = \mu\,l + \mu_2\,l$,

$$\text{(X.)} \qquad \text{P}_3 = \frac{5}{8}\,(\mu_2 l + \mu l)$$

To find the point of contrary flexure in the curve A R B; or where $\frac{d^2 y}{d x^2} = 0$.

Referring to equation (II.), we have $0 = \frac{\mu x^2}{2} - \text{P}_1\,x$,

$$\text{or}\ x = \frac{2\,\text{P}_1}{\mu}\ \text{at the point of contrary flexure.}$$

It is evident that at this point, $\phi = 0$, *i.e.*, there are no elastic forces exerted, and therefore there are no longitudinal strains, either of extension or compression, on any of the fibres of this section of the beam.

We may now proceed to calculate the strength of the part A B of the beam; and this resolves itself into the question, What is the greatest longitudinal strain on the fibres of the beam, when bearing a given load?

Let the load distributed over the length $\text{AB} = \mu\,l$, as before.

Now in order to find the place in this length where there is the

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[*] If $\mu = \mu_2$, *i. e.* if the load is equal on both sides of the centre pier,

$$\text{P}_1 = \text{P}_5 = \tfrac{3}{8}\,\mu\,l,$$
$$\text{P}_3 = \tfrac{10}{8}\,\mu\,l.$$

greatest strain on the fibres, or where ϕ, the moment of the elastic forces, is at a maximum, differentiate equation (I.) and make $\frac{d\,\phi}{d\,x} = 0$. We have thus

$$\text{(XII.)} \quad 0 = \mathrm{P}_1 - \mu x, \text{ or } x = \frac{\mathrm{P}_1}{\mu} \text{ at the place of greatest strain.}$$

This, it will be observed from equation (XI.), is half way between the end of the beam and the point of contrary flexure.

Substituting between equations (I.), (VIII.), and (XII)., we have, for the moment of elastic forces at the section of greatest strain.

$$\text{(XIII.)} \qquad \phi = \frac{(7\,\mu\,l - \mu_2\,l^2)}{512\,\mu}$$

It is capable of proof,* that if f = the longitudinal strain, per square unit of area, on any fibre of the beam; c = distance of that fibre from the neutral line, and I = the moment of inertia of the section of the girder round the neutral line; then

$$\text{Moment of elastic forces} = \phi = \frac{f}{c}\,\mathrm{I}.$$

Therefore by equation (XIII.), at the section of greatest strain,

$$\frac{f}{c}\,\mathrm{I} = \frac{(7\,\mu\,l - \mu_2\,l^2)}{512\,\mu}$$

$$\text{or, } f = \frac{c\,(7\,\mu\,l - \mu_2\,l^2)}{512\,\mathrm{I}\,\mu}$$

which, by using the proper value of c, will give the greatest strain, either of extension or compression, on any of the fibres of the beam, and will thus determine the *strength* of the beam to resist a given load.

Application to the Torksey Bridge.

The following are the values of the given quantities for the case in question:—

l = width of each opening = 1560 inches.
$\mu\,l$ = load on AB = 400 tons, or for each girder = 200 tons.
$\mu_2\,l$ = load on BC = 164 tons, or for each girder = 82 tons.
E = modulus of elasticity, is taken at 10,000 tons † for a bar one inch square.

To find the position of the neutral line.

It is known that when the material of a beam is perfectly elastic, the neutral axis of any transverse section passes through its centre of gravity.

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* *Vide* Britannia and Conway Tubular Bridges. Equation i., page 244.

† The value used for the deflexion of the Britannia and Conway Tubular Bridges.

By the application of this rule to the section of the Torksey bridge girders, the neutral line is found 64 inches from the top, or 56 inches from the bottom of the section.

To find the moment of inertia I *of the transverse section round its neutral axis.*

Since we have $I = \Sigma \rho^2 \Delta k$, the moment of inertia is obtained by adding together the moments of all the separate parts of the section.* The moments of the horizontal plates are found by simply multiplying the area of each by the square of its vertical distance from the neutral line; those of the vertical plates by the application of well-known analogous rules. The following are the results, derived from two independent computations. The dimensions are taken in inches.

Moment of inertia of the section of the girder, round the neutral line.

Compressed portion—	
Top plates	73,700
Vertical plates of cells	41,700
Bottom plates of cells	51,700
Portion of side plates	21,100
Total moment of compression	188,200
Extended portion—	
Portion of side plates	28,500
Bottom plates	155,800
	184,300
Total sum of moments = I	372,500

The values of the pressures on the three points of support are obtained from equations (VIII.), (IX.), and (X.) They are for each girder

$$P_1 = 82 \cdot 375 \text{ tons}$$
$$P_5 = 23 \cdot 375 \text{ ,,}$$
$$P_2 = 352 \cdot 500 \text{ ,,}$$

The value of $\tan \beta$ (β being the angle the girder makes with the horizontal), at the point B, is obtained from equation (IV.)

$$\tan \beta = -0 \cdot 0014955$$

The distance of the point of contrary flexure from A, is, by equation (XI.) = 1285 inches, or 22 feet 11 inches from the centre pier.

The deflexion of the loaded span of the beam is obtained by equation (III.) and that of the unloaded span by one similarly deduced. The deflexion of the unloaded beam may be found in a corresponding manner, and all three are united in the following table:—

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* *Vide* Britannia and Conway Bridges, page 244.

CALCULATED DEFLEXION of the TORKSEY BRIDGE, under the specified load.

Distance from End.		Deflexion of Loaded Girders.	Deflexion of Girders from their own Weight.	Deflexion due to Load.
	Feet.	Inches.	Inches.	Inches.
End Pier A	. .	0·00	0·00	0·00
Loaded Span.	10	+0·41	+0·13	+0.28
	20	0·79	0·25	0·54
	30	1·12	0·35	0·77
	40	1·36	0·42	0·94
	50	1·50	0·45	1·05
	60	1·55	0·45	1·10
	70	1·49	0·42	1·07
	80	1·34	0·35	0·99
	90	1·11	0·27	0·84
	100	0·83	0·18	0·65
	110	0·53	0·10	0·43
	120	+0·24	+0·03	+0·21
Centre Pier B	.	0·00	0·00	0·00
Unloaded Span.	120	−0·14	+0·03	−0·17
	110	−0·20	0·10	−0·30
	100	−0·21	0·18	−0·39
	90	−0·18	0·27	−0·45
	80	−0·12	0·35	−0·47
	70	−0·06	0·42	−0·48
	60	−0·01	0·45	−0·46
	50	+0·04	0·45	−0·41
	40	+0·07	0·42	−0·35
	30	+0·07	0·35	−0·28
	20	+0·06	0·25	−0·19
	10	+0·02	+0·13	−0·11
End Pier C	. .	0·00	0·00	0·00

The greatest longitudinal strain on the fibres of the beam is determined from equation (XIV.) as follows:—

To find the greatest compressive strain on the top plates, we must make $c = 64$ = the distance of these plates from the neutral line; whence $f = 4 \cdot 55$ tons per square inch greatest longitudinal compressive strain on top plates.

For the bottom plates $c = 56$, whence $f = 4$ tons per square inch greatest longitudinal tensile strain on bottom plates.

The advantage gained by the continuity of the girder across the two openings, is shown by the following table. The first column applies to the continuous girder; the second contains the corresponding strength and deflection calculated for an independent girder spanning one opening only. It will be seen that the effect of the continuity is to increase the strength in the ratio of about 3 to 2, and to diminish the deflection in a still larger proportion.

	In the continuous Girder.	In an independent Girder spanning one Opening only.
	Tons per sq. in.	Tons per sq. in.
Compressive strain on top plates . . .	4·55	6·75
Tensile strain on bottom plates	4·00	5·90
	Inches.	Inches.
Deflexion by weight of structure only . .	0·45	1·08
Deflexion with load added	1·55	2·65

Captain SIMMONS regretted he was not in a position to enter fully into the discussion, at that time, as the question of the adequate strength of the Torksey bridge was still under the consideration of the Commissioners of Railways, the official consent not having been given for its being used for the purposes of traffic. He might, however, observe, that the remarks which had been made appeared to have been based on the consideration of a homogeneous beam of perfectly elastic construction, whereas, he could not admit that the top of the girder in question was equally adapted to resist a tensile strain, as it was to support the action of compression; he, therefore, did not think that the observations which had been made, could be applied to the bridge in question.

Mr. C. H. WILD admitted, that the top of the girder was not as well calculated, as the bottom, to bear a tensile strain; consequently, in the experiments, adequate allowance had been made for the diminished value of the top. It would be perceived, that the only discrepancy between the results arrived at by Mr. Pole's calculations and Mr. Wild's experiments, arose from the fact that no allowance for the diminished strength of the top of the girder over the support had been made in the former case.

Major-General Sir CHARLES PASLEY observed, that having accidentally met one of the officers of the Commissioners of Railways, he was told a difference of opinion existed between the Board and Mr. Fowler, on account of a tubular girder bridge which was not considered sufficiently strong, although in a span of 130 feet there was only a deflection of 1¼ inch when six locomotive engines, weighing 222 tons, were placed on it. If such a case had been brought before him, in his former position of Inspector-General of Railways, he should at once have approved of that bridge, as he considered that a deflexion of 1 in 1,248 was utterly insignificant, and was a sufficient proof of the strength of the bridge, which he thought would last as long as the materials remained good. He was informed, the cause of objection was, that calculating the breaking weight according to a formula laid down by Mr. Eaton Hodgkinson the ultimate strength was not considered sufficient. General formulæ were undoubtedly useful, but they might be misapplied, and there was an instance on record, of two engineers arriving at a difference of 2 to 1 in their calculations of the breaking weight of the same bridge, though they both used the same rule.

He was not at all convinced, that a rolling weight in motion exerted a much more pernicious influence than a weight remaining stationary, as had been asserted. The most conclusive experiments on that subject made by the Iron Commissioners were those on the Ewell and Godstone bridges, as detailed in their Report; in the former of which the stationary weight produced a deflexion of $\frac{1}{5}$th of an inch, in a span of 48 feet, whilst it was only increased by $\frac{1}{7}$th of that deflection when the train passed over the bridge at the rate of 50 miles an hour. The experiments at Portsmouth and Cambridge, for the Iron Commission, though arranged with great ingenuity, he considered to be of little value, on account of their having been tried on too small a scale, and owing to the velocity having been acquired too near the bottom of a curve, resembling the descending portion of the centrifugal railway, which he did not think was a satisfactory system. He thought the fairest test of the strength of the Torksey bridge would be, to run over it a heavy goods-train, fully loaded with coal, or iron, and drawn by two powerful engines, at various velocities, from 5 miles to 30 miles an hour; or by trains of passenger-carriages, proportionably loaded with iron, running at various speeds, up to 60 miles an hour; and that the successive deflexions caused by each of these trains, when in motion, should be carefully noted. The experiments thus suggested to be tried on the bridge itself, with the heaviest goods and passenger trains that could ever pass over it, and at the highest possible speed they were capable of attaining, could not fail to be conclusive; and if, as he believed, the maximum deflexion obtained, should prove to be less than that caused by the greater weight of the six engines at rest, it might be considered a decisive proof of the strength and safety of the construction.

He did not attach much importance to the effects of impact and vibration, because Mr. Eaton Hodgkinson's recent experiments had convinced him, that the shocks to which railways were liable under ordinary circumstances, from an accidental obstacle on the rails, could not do any positive injury to this bridge.

He thought the continuity of the girders in the Torksey bridge, was a point of vital importance, and would venture to allude to the Chester bridge, over the Dee, in confirmation of the position. It was true that a single cast-iron girder might give way without warning, but it was a very different case when the girders were continuous. The Dee bridge was quite as strong, in proportion, as that over the Ouse, at York, or any of the bridges of the same sort that had been built, and which had stood safely for years; the only difference was, that in the Dee bridge the girders were independent of each other, and in the former bridges, of the same sort, they were continuous. He looked on that want of continuity in the girders of the Dee bridge, to which unfortunately, he did not give sufficient attention when he first inspected it, as the sole cause of its failure.

Professor **Willis** hoped he might be allowed to add a few words, on the experiments as to the effect of velocity on the safety of bridges, as he had been engaged in carrying them on. He thought if General Pasley had studied more carefully the Report of the Commissioners, he would have modified his observations, with respect to the possible increase of deflexion from velocity, in a bridge of 130 feet span, comparing it with one of 30 feet. The theory and deductions given in Appendix B., of that Report, had shown, that the increase of deflexion produced by the velocity of the load, diminished rapidly, when the length of the bridge was increased, and that in so great a span as that of the Torksey bridge, this increase was so small as to be wholly insignificant. In framing their Report, the Commissioners had guarded this assertion in every manner, supporting the theory by experiments, tried with the utmost accuracy, permitted by the limited time and means at their disposal. The experiments at Portsmouth were tried on bars of a large size, considered as experiments, but their length of 9 feet was necessarily small, compared with the span of real bridges; and it was true that in them the increase of deflexion by velocity had developed itself to an extent that was of serious importance. He had, however, shown by theory, and by the subsequent experiments at Cambridge, that as the span and weight of the bridge increased, and the statical deflexion diminished, the increase of deflexion from velocity became wholly unimportant. The results of those investigations should convince engineers and the public, that from that cause they had nothing to fear. He was quite ready to defend the principle on which the velocity was obtained, in the experiments at Portsmouth, namely, by allowing the load to run down an inclined plane, and then conducting it by a gentle curve to the horizontal direction, so as to pass it steadily over the horizontal trial bars. He saw no other method of performing the experiments, and could not understand what the centrifugal railway, alluded to by General Pasley, had to do with the question.

Mr. **Rennie** said, the remarks he intended to have made, were in a great measure anticipated by what had fallen from Professor Willis. The effects of increased velocity, as shown by the experiments at Portsmouth, had at first surprised the Commissioners; but subsequent experiments, tried on a larger scale, on real bridges, showed that effect to be practically of comparatively little importance. It was stated in the preliminary part of the Report, that although the bars of cast iron on which Mr. Eaton Hodgkinson experimented, "resisted the effects of 4,000 blows, each bending them through one-third of their ultimate deflexion," the 10,000 blows inflicted by Captain James, in his own experiments, at Portsmouth, produced "no very perceptible effect" on wrought-iron bars. He was prepared to receive the opinion of Mr. Fairbairn with great respect, whether he adopted for a constant 80, or any other figure, as that gentleman had devoted much attention to the subject, both theoretically and practically. Still, he felt bound to say, he did not consider the form of tubular bridges the best that could be adopted, however he might admire the experiments and investigations of Mr. R. Stephenson, Mr. Hodgkinson, and Mr. Fairbairn. He preferred the bow-string form, which was that of the trussed roof of ancient times, and he thought the material was thus placed in the ratio of tensile strength of wrought iron, to the compression of cast iron, in the most advantageous manner. It had been long known and exemplified by Emerson and other writers, that continuous beams were much stronger than isolated beams.

Mr. J. **Scott Russell** wished to bear testimony, to the value of the only portion of the Commissioners' Report, that he had been able to examine carefully, and he thought, that no arrangement could have been more satisfactory than that made by Professor Willis, for his experiments,* in the result of which he was, therefore, prepared to place great confidence.

The main point in the present discussion was, whether the continuity of the tube across the central pier should be admitted to have added such additional strength to the girders, that the ultimate strength of the bridge was as great as might be necessary to insure perfect safety.

Now he must submit, that the mathematical investigations of Mr. Pole, and the experiments of Mr. Wild, which were equally creditable to their theoretical attainments and their practical skill, completely demonstrated the advantages of the continuity; and unless that element was taken into consideration, in calculating the strength of the girders of the Torksey bridge, the decisions with respect to its presumed instability were valueless.

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* *Vide* Report of the Iron Commission, page 181.

The model exhibited the form of the girder in its actual condition, and demonstrated the enormous addition to its strength at the expense of a very small quantity of material; it was certainly, then, a radical error to omit so important a consideration as the continuity over the central pier, and any formula which neglected that element could not be accepted by the profession; but it was even less excusable, that a structure, which had been shown, both theoretically and practically, to possess the requisite amount of strength, should have been rejected because an officer of the Government, acting under the sanction of an Act of Parliament, had applied to a comparatively new system of construction, an antiquated formula, for which it was never intended.

Mr. FAREY addressed to Mr. Fowler several questions, as to the thickness of the material in the different parts of the girders, the arrangement of the plates of iron, and the value of the angle-irons in conducing to the strength.

The metal in the vertical sides should not certainly be overlooked, whether it must be considered as mere dead weight, tending to break down the girder, or whether it contributed to the actual strength. All that was stated on the subject, in the paper, was, "that the sides were to be sufficiently rigid to retain the girder in shape." It was, however, a question, what thickness of metal would suffice for that purpose, and what system of bracing should be adopted to prevent buckling. According to Mr. Fairbairn's formula, the sides were not to be considered in calculating the strength of the bridge, in which case it would be an improvement to omit them entirely from the bridge; or, on the other hand, should they not be introduced into the formula, as they would certainly introduce themselves in the consideration of the cost of the bridge?

It appeared, that in the dimensions taken for computing the sectional area of the metal, no allowance was made for the loss from the rivet-holes; unless this consideration was an element in the formula, it must evidently be faulty. He could not implicitly receive the rule, and hoped it would be very rigidly examined, as, unless it was strictly correct, it might prove very mischievous. Practical men, to save themselves trouble, were very willing to adopt a simple rule, if it came to them well recommended to their confidence; and such adoption of an empirical rule was a great impediment to the projecting of any new system, by diverting the attention of practical men, from inquiring into the real action of the contending forces, under different conditions. The paper appeared to be limited to the recommendation of a formula, which certainly should be subjected to severe scrutiny, and a more definite demonstration of its efficiency should be required.

Mr. Fowler stated, in answer to Mr. Farey's questions, that the metal of the vertical sides varied in thickness; for 22 feet over the central pier it was $\frac{6}{16}$ inch thick, then for the next 34 feet it was $\frac{5}{16}$ inch thick, then for 50 feet it was $\frac{4}{16}$ inch thick, then for the next 34 feet it was again $\frac{5}{16}$ inch thick, and for the next 12 feet it was $\frac{6}{16}$ inch thick. In plan, for a length of 50 feet over the central pier, the metal of the bottom plates was $\frac{6}{16}$ inch thick, then for 20 feet it was $\frac{8}{16}$ inch thick, then for 50 feet it was $\frac{12}{16}$ inch thick, then for the next 20 feet it was again $\frac{8}{16}$ inch thick, and then for the next 26 feet $\frac{6}{16}$ inch thick (Figs. 4 and 5). There was an additional bottom-plate, 12 inches wide and varying in thickness from the centre of the opening to the piers, in the same proportion as the bottom-plates, as shown in Fig. 5; but this plate did not extend over the centre pier, nor above those parts of the girder which rested upon the abutments.

The vertical plates in the top were $\frac{4}{16}$ inch in thickness throughout. Nine angle-irons only were taken into the calculation, as one-half of the two lower angle-irons was riveted to the sides. In the calculations, the packing strips were considered to be in as good a position, to resist tension, as the bottom plates themselves, but as the angle-irons were not strained in the same manner they were omitted.

Mr. Colthurst said, that as the strength of the sides of the main girders had not been given separately, he could state as a result of some calculations he had made, that they were equal to a strain of 270 tons, distributed uniformly over one opening.

Mr. Glynn was glad the question of continuous beams had been brought forward: it was well known to old carpenters, that if two joists spanned over two openings, the ultimate strength was not so great as when one joist stretched over the two spaces, in fact the difference of strength was as 2 to 3, and that result had been shown to obtain in the bridge in question.

With respect to the velocity of trains passing over a bridge, it ought to be borne in mind, what the effect would be if the velocity was infinite, or nearly so, in a horizontal bridge; he apprehended, that in such a case, a less strain would be thrown on the bridge than if the weight was quiescent.

Mr. Walker said, if it had not been for objections made by the Admiralty and their Hydrographer, to any obstruction in the way of the navigation of the Menai Straits, the Britannia Bridge never

Fig. 4.

ELEVATION.

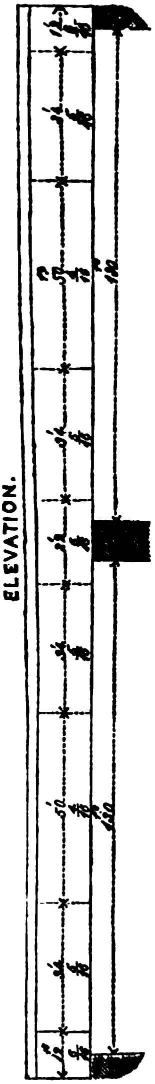
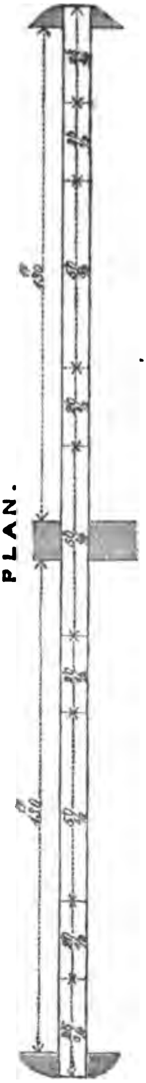


Fig. 5.

PLAN.



Diagrams showing arrangement of Plates in bottom and sides.

would have been erected; and had it not been for inferences drawn from the Report of the Commissioners, and the application to wrought iron, of a formula intended only for cast iron, the Institution would not have had Mr. Fairbairn's paper, nor the interesting discussion which had arisen out of it. It appeared to be considered, that the tendency to fracture was to be measured by the amount of the deflexion, but he did not gather, from anything that had been stated, that impact had practically any important effect in a structure of that magnitude, constructed of materials possessing such an amount of elasticity, and so disposed as to exert the utmost tensile force.

Professor **Willis** replied, that the point raised by Mr. Walker was one, which, in the present state of knowledge, he was unable to answer. The Commissioners had intended to have tried some experiments on that point, in order to ascertain what amount of deflexion would be exhibited, before the breaking point would be arrived at in wrought iron, as well as the effect of impact in cases of that kind, but their time had expired, and their money was expended, before that part of the subject could be investigated.

Captain **Simmons** denied that he had made use of a formula only applicable to cast iron. When he reported on the strength of the Torksey bridge, he took into account the area of the entire section of the wrought-iron girder; but he certainly did not take into account, the fact of its being a continuous beam, though he fully coincided with Mr. Scott Russell in the practical value of that principle; because he believed the beam in question was not so constructed, over the central pier, as to support all the strain which might be brought upon it, and therefore he thought the paper which had been read, however interesting, did not apply to the case in question. He could not subscribe to Mr. Bidder's statement, that the strain brought on the bridge would not exceed five tons to the inch, because he could not admit the reduction of the spans, to the extent endeavoured to be shown by the calculations and the diagrams that had been exhibited.

Mr. **Bidder** said, his remarks at the commencement of the discussion, were based on the objection he felt to the application of an empirical formula, laid down by Mr. Fairbairn, and he believed, that with a single exception, that formula had been condemned by every speaker; it did not take into account several material elements, which ought to be regarded in the consideration of the strength of tubular bridges; it did not notice the effect of continuity, nor the quantity of metal in the sides of the girders. These were material omissions, in a paper which proposed to lay down rules for the proportions of tubular girders. When it could be shown by calculation, that one-third of the strength of the girders of the Torksey bridge was derived from the material in their sides, he must contend, that a case had been made out, showing that any formula, which omitted that element from its consideration, was imperfect, and was not to be relied on.

With regard to the continuity, he had ascertained, from his own calculations, that the deflexion of a simple girder, of that span, without continuity, would be 2 inches; whereas the result of the experiments had shown the actual deflexion to be 1¼ inch, and he was prepared to show, that the strain did not amount to 5 tons on the square inch of section.

He had also directed attention to the vague feeling which existed, that the movement of a train over a tubular bridge, imparted a great strain to the bridge, by impact, or concussion; that point might henceforth be dismissed from their consideration; no one had ventured to offer an opinion, that it had the slightest practical effect, on beams of that extent. Before such a girder could be injured, the rails on which the train travelled must be crushed, or broken, and he believed, that the rails throughout the kingdom were daily and hourly submitted to a much greater strain.

The case then resolved itself into the simple question, Why was the Torksey bridge rejected, and what evidence had been given to justify such a step? Captain Simmons had Mr. Fairbairn's paper before him, and might have explained why he had not even acted on the suggestions contained in it. He thought the time had arrived, when they were entitled to know the real grounds on which the public had been deprived of the convenience of the railway, and the Company had been subjected to the loss they must have sustained by its being kept closed.

Mr. C. Manby, *Secretary*, said, he was instructed by Mr. Fairbairn, to express his regret at not being able to be present at the discussion of the paper, which had been prepared for the double purpose of affording information to the Railway Commissioners, and for raising a discussion before the Institution. He had approached the inquiry without any partizan feeling, and had endeavoured to bring forward only practical facts. He was directly opposed to unnecessary interference with the professional responsibility of either civil, or mechanical engineers, and in this, as in all similar cases, he thought it better, that the opinions entertained should be embodied in a paper, and be submitted to the tribunal of the Institution, where they would receive fair and candid consideration. In revising his first views, he had deemed it expedient to modify his proposition for the proportion of the depth of the girder, to the span, and had now concluded that it was preferable to reduce the depth for the larger spans.

He thought the reasons were satisfactory, for not taking into account the continuity of the girder, when calculating the ultimate strength; he was aware of the difference of opinion on that point, but he deemed it safer to disregard that element, as he had explained in a note to the paper (page 6).

He wished it to be distinctly understood, that he had never contemplated any attempt to assign empirical rules for the practice of engineers; he was anxious to submit his views and calculations, to the test of the careful consideration of the authorities of the profession, desiring to have the subject fairly discussed. Still he had implicit confidence in the accuracy of the formula, and he was supported in that confidence by some of the first mathematicians of the day. The formula had afforded the most satisfactory practical results, and he had found its efficiency perfectly consistent, in every instance of its application; nevertheless he was quite open to conviction, and would be most happy to receive a better rule; but until one was found, he must still adhere to that which he had proved to be practically correct; and as nearly all the tubular-girder bridges, hitherto erected, had been constructed according to that formula, and had proved successful, he contended it would not be wise to discard it until a better could be substituted for it.

In order to complete the narrative of the events connected with the examination of the Torksey bridge, it is necessary to give a succinct analysis of the Reports of the Inspecting Officers to the Commissioners of Railways, and of the correspondence between the Board and the Engineer of the Railway on which the bridge in question is situated.

In a Report dated December 24, 1849, Captain Simmons stated, that he had tested the girders by bringing on to the two lines, over one opening, four engines with their tenders, weighing together 80 tons, when the deflection of each beam, or tube, was found to be nearly 1¼ inch. The beams appeared to possess sufficient strength to support the weights that might come upon them in practice, but were not built in a very accurate line, nor were they very accurate in form; and several rivets appeared to be not very perfect. The deflection was more than he anticipated under such a load, and considering the very light construction of the bridge, the superstructure over each span being only about 180 tons, and that the load which might come upon it in the event of two trains passing each other on one bay, would bear a large proportion to the permanent load, or weight of the bridge; and considering also the amount of deflection under the test applied, he did "not feel sufficient confidence in the construction, to recommend the Commissioners to authorize the opening of the line for the conveyance of the public, unless some means were contrived for stiffening the bridge."

In a letter to Captain Simmons, dated January 2nd, 1850, Mr.

Fowler directed his attention to an error in his calculations, arising from his having assumed 80 tons as the weight of the four engines and tenders, whereas their actual weight was 148 tons. Applying this latter weight, it was submitted, that the bridge was abundantly strong, and that the deflection was less by one quarter of an inch, than might have been anticipated.

To this, Captain Simmons replied, January 5, 1850, that making full allowance for the error into which he appeared to have fallen respecting the weights of the engines, he still maintained the opinion, that the tubes were not sufficient to maintain continuously, for a long period, the strains to which they might be subjected, so long as they were used according to the present construction of the bridge.

In a report to the Commissioners under the same date, Captain Simmons reiterated his former opinion, and stated that the conclusions at which he had before arrived, still remained unshaken, and that he could not report that the opening of the railway for the conveyance of the public would be unattended with danger.

On the 7th of January, Mr. Fowler requested that the bridge might be subjected to a more severe test, suggesting that 250 tons should be placed upon each opening; and he further had no hesitation in asserting, that the Torksey bridge was a stronger and better structure than any tubular girder bridge yet erected by him, and he believed he had constructed a greater number of large wrought-iron tubular girder bridges than any other engineer, and none of them had exhibited the slightest symptoms of weakness, or inefficiency.

This further trial was ordered to be made, and on the 21st January, Captain Simmons reported, that on the the 11th January, he had applied the following tests:—

"Three engines, the weights of which were given to me by the locomotive superintendent as together amounting to 108·075 tons, when fully loaded, were placed upon the south road, and produced a deflection of the south beam of ·6 of an inch, and of the north beam, of ·36 of an inch.

"Three more engines, together weighing with their loads, 114·6125 tons, were then placed upon the north road, which increased the deflection of the south beam to 1·20 inch, and of the north beam to 1·32 inch. These deflections were entirely due to the temporary load, and therefore in addition to the permanent deflection due to the constant load, and corresponded as closely as could be expected with the result, which was to be anticipated, from the calculations I had made from the drawings and dimensions furnished to me by the engineer, which gave a deflection of 1·41 inch for an evenly distributed load over the whole bridge of 222·6875 tons, which was the stated weight of the six loaded engines."

This he considered as a verification of the former calculations, and therefore he remained of the same opinion as to the danger to be apprehended from the use of the bridge.

The opening of the line was therefore further postponed, by order of the Commissioners, for one month from the 22nd January.

Mr. Fowler then made application for a copy of the instructions under which the inspecting officers acted, as their practice appeared to have been recently changed.

On the 25th January, Mr. Fowler requested to be informed by Captain Harness what amount of deflection in the girders of the bridge under a weight of 222 tons would indicate sufficient strength. At the same time, he directed the attention of the Commissioners to the difference of opinion, entertained by engineers, as to the meaning of the paragraph in the Report of the Iron Commission,* which was understood to be the basis of the rule of calculation, followed by the inspecting officers. It was believed, that the Iron Commission did not intend to give any opinion on wrought-iron girders, and that the multiple of 6 for cast-iron, was only that the ordinary passing load should not exceed one-sixth of the breaking weight. It was premised, that Captain Simmons used the multiple of 6 as between the sum of the girders and roadway, and the greatest passing load and the breaking weight; also that three times the girders and six times the greatest load would be sufficient.

Mr. Fowler then furnished the Railway Commissioners with the opinions of several eminent engineers, in favour of the sufficiency of the bridge, and proposed to meet the objections of the Commissioners, by such an arrangement of the top planking of the platform, as should preclude the possibility of a greater thickness than two inches of ballast, ever being superposed.

On the 21st of February, the Commissioners ordered a further postponement of the opening of the line for one month, in consequence of another report by Captain Simmons (dated February 20th), in which, after explaining to the Commissioners, that he had given the matter his most earnest consideration,—had consulted eminent authorities, and had taken steps to obtain the details of such bridges, of similar construction, as appeared likely to afford information as to the effect of time and continuous use upon such structures, he proceeds to reply seriatim to the questions contained in the instructions of the Commissioners, and states:—"In reply to the question, 'whether, if I still remain of opinion, that this viaduct cannot be opened with safety to the public, what further strengthening will be necessary,' I have to state, that for reasons before adduced, I do not consider, that the viaduct can be opened for the continuous passage of trains, with safety to the public, and that it will not be in a condition to be opened, until it shall have been so strengthened, that a load of about 400 tons, (including the weight of the beams themselves, and all the standing parts of the bridge) distributed equally over the platform of one span, shall not produce a greater pressure upon the top plate of the girders than five tons per square inch. In stating this, I have taken what I conceive should be the utmost limit of strains, to which the bridge should be subjected by the given load, considering its nature, nearly 200 tons being made up of railway trains in motion, and the doubtful workmanship in the structure.

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* "That, as it has been shown that to resist the effects of reiterated flexure iron should scarcely be allowed to suffer a deflection equal to one-third of its ultimate deflection, and since the deflection produced by a given load is increased by the effects of percussion, it is advisable that the greatest load in railway bridges should in no case exceed one-sixth of the weight which would break the beam when laid on at rest in the centre."—*Vide* Report of the Iron Commission, page xviii.

"In arriving at this conclusion, I express my opinion with all diffidence, as there is no decided authority upon the subject, and the peculiar circumstances of construction of most bridges very considerably preventing the application of an universal law. Mr. Hodgkinson, whose authority in these matters is entitled to great deference, states, that he conceives that eight tons per square inch is the greatest compressible strain to which a tube of this sort should be subjected; and again, in speaking of the Conway bridge, he states, that a tube of given dimensions, 'if made without joints and loaded without vibration, would bear a weight in the middle of 1,627 tons (equal to twelve tons per square inch pressure on the top) without entirely destroying the utility of the material; but plates united by riveting in the best manner in common use, are weaker than plates without joints, in the ratio of three to two nearly; we ought therefore to reduce the computed weight in that ratio, or even greater, since the computation is made on the supposition of the tube being without joints and loaded without vibration.' And again, in commenting on an experiment made upon a large tube forty-seven feet long and about six and a half tons weight, built up of plates three-quarters of an inch thick, being thicker, in fact, than the chief part of the plates in the Torksey bridge, he states, that 'long-continued impact producing a deflection of less than one-fifth of what would be required to injure the tube by pressure, was completely destructive to the riveting.'

"The great weight of the Menai and Conway bridges in proportion to their load, producing vibration (about 1 to 4·5 in the Conway) will obviate this danger; but it appears a question to what extent allowance should be made for this effect, when the proportions of the variable and permanent load are altered, and, as in the present case, become nearly equal to one another. The deflection due to the rolling load, stated to be 222 tons, which I saw upon the bridge, very considerably exceeds one-fifth of the ultimate deflection which the tube may be expected to bear, and it is to be remembered, that this deflection is in addition to the constant effect of the permanent load.

"Mr. Fairbairn, in his letter forwarded by Mr. Fowler, states, that experiments, which he has in his own possession, on the force of impact on his tubular bridges, and on heavy weights passing over these bridges, appear to confirm the fact, that the deflection in the former is a result due to the height through which the body falls, and in the latter, the deflection is the same at all velocities. In this I agree, to a great extent, with Mr. Fairbairn, that the increase due to the velocity is not, practically speaking, in most cases applicable, and I believe in the present instance it would scarcely be at all so; but, nevertheless, I cannot go so far as to attach no value to the experiment on impact, by Mr. Hodgkinson, before given, the effect of which is again aggravated by the concussions caused by the irregularity of motion of the moving weight.

"I would further remark, that in this question, much must depend upon the nature of the riveting; where machines are used for that purpose, a better result may be expected than when it is done by hand, and again the weight of hammer used, or force of blow in forming the rivet-heads, will make a material difference. In the Torksey bridge, from having seen several split rivet-heads, I have no great confidence in the workmanship."

He concludes by stating, that he had again inspected the bridge,—that no addition had been made to its strength,—that he had re-examined the tubes with reference to their workmanship, and found he was fully borne out in the expression of a want of confidence in it, as the riveting was certainly very imperfect, and the joints were not accurately, or very judiciously made, and the top of the girders was considerably out of line, both horizontally and vertically, therefore in his opinion the opening of the line would be attended with danger "by reason of the insufficiency of the work."

Mr. Fowler then pointed out, that Captain Simmons had evidently neglected the increase of strength due to the continuity of the tubes over the centre pier.

Captain Laffan was then instructed to examine the bridge, and the result was, that on the 18th of March the opening of the line was further postponed for one month.

In the report, dated March 16th, Captain Laffan stated, that the bridge remained precisely in the same condition as when it was inspected by Captain Simmons, on which occasion he decided, that the wrought-iron girders were not sufficiently strong to insure the safety of public traffic. After a careful inspection of the structure, Captain Laffan entirely concurred with Captain Simmons in his opinion, and further "that the opening of the line would be attended with danger to the public, by reason of the insufficiency of the works."

On the 20th of March, Mr. Fowler addressed a letter to the Commissioners, in which, after remonstrating on the shortness of the notice of the intended visits of the Inspecting Officers, which had precluded the possibility of his being present at the inspection of the works,—he examined and commented on the report of February 20th, by Captain Simmons, protesting against the conclusion, that five tons per square inch was the greatest strain to which the metal in the bridge might be safely subjected, inasmuch as Mr. Eaton Hodgkinson's experiments showed, that a compressive strain of eight tons per square inch was perfectly safe.

He also protested against the objection to the workmanship, which although not of the finest and most finished class, was nevertheless perfectly sound, and, for all practical purposes, as good as possible; the slight deflection of 1·26 inch under a weight of 222 tons as stated by Captain Simmons, appearing conclusive against any charge of imperfect workmanship. Mr. Fowler therefore concluded, that there was not any sufficient reason for fixing upon five tons, as the greatest strain to which the bridge could be safely subjected, when no good authority had even suggested a strain of less than eight tons as being perfectly safe.

Assuming, however, that Captain Simmons was justified in his extraordinary requirements for the bridge, Mr. Fowler contended that without any alteration, it actually did comply with those stringent requirements.

In the paper on Tubular Girder Bridges, alluded to by Captain Simmons, Mr. Fairbairn gave a table of fixed proportions, recommended by him, but which were adapted for simple girders over one opening, and in applying his own rule to this case, Mr. Fairbairn arrived at the conclusion, that although the Torksey bridge did not come up to his standard, the dimensions "were nevertheless sufficient to render the bridge perfectly secure." This conclusion had been arrived at, by treating the bridge as composed of separate and distinct girders; but if Mr. Fairbairn had ascertained the value of the continuity over the centre pier, he would have perceived the enormous additional strength thus imparted to the structure, and that it was fully equal even to the requirements of his own assumed standard.

The condemnation of the bridge by the Inspecting Officers, could only be accounted for, by supposing that they had overlooked, or failed to appreciate, the value of the continuity of the girders, which Mr. Fowler had ascertained, by experiment and by calculation, did actually impart additional strength to the bridge in the proportion of 9 to 14, and a reduction of the compressive strain upon the top plates to 4·60 tons per square inch.

Under these circumstances, Mr. Fowler felt "it impossible to recommend the Railway Company to make any addition whatever to the strength of the Torksey bridge."

At the meeting of the Institution of Civil Engineers on the 26th of March, the increase of strength due to the continuity of the girder over the centre pier, was fully demonstrated;* but in order to induce conviction on the minds of the Commissioners, it was resolved further to test the results of the theoretical investigations, by experiments conducted on a large scale, and under the actual circumstances of the case. For this purpose Mr. Fowler obtained the assistance of Mr. Pole and Mr. C. H. Wild; and proceeded with them to make a series of experiments on the bridge. These were tried on the 28th of March, 1850, in the presence and with the aid of Captain Simmons and Captain Laffan, and were of the following nature.

The bridge was loaded with ascertained weights, applied in different ways, and the deflection of the northern girder† was taken in various parts of its length, before, during, and after, the application of each load. It was not thought necessary to observe the southern girder also. The manner of taking the deflection was by observations with a level, this being considered more convenient and satisfactory, than by means of a stretched wire. For this purpose a level was firmly fixed on the western pier of the north girder (corresponding with the point A on figure 3), and the horizontal wire of the telescope adjusted to a horizon mark on the eastern pier (C, fig. 3). When, therefore, the deflections were to be taken, a staff, graduated with inches and tenths, was held at various points on the top of the girder, in the line of sight of the telescope, and the reading of the horizontal wire upon the staff noted down. The difference between any two readings for the same point of the girder, under different loads, showed the amount of alteration of level, or deflection, at that point.

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* *Vide* ante, page 23 et seq.

† The line of railway at this point runs nearly East and West.

In this manner the following trials were made; the observations being taken in each case at points 10 feet apart, as stated in the table of results given hereafter.

1. A series of readings was first taken with the bridge unloaded, *i. e.* the girders sustaining the weight of the structure only. This weight was estimated, by a careful calculation, to be about 145 tons, or 72½ tons on each girder.*

2. Nine waggons, loaded so as to weigh 16 tons each, total 144 tons, were distributed over the western opening of the bridge (A B, fig. 3), and readings were taken again, at the same points as before.

3. This load was removed, and readings were taken again with the bridge unloaded.

4. The same load as in No. 2, was distributed over the eastern opening (B C, fig. 3), and readings were taken.

5. The load was removed, and the readings were again taken with the unloaded bridge.

The above readings, being recorded at the time by several parties, were subsequently reduced and compared as follows:—

The mean of the readings, Nos. 1, 3, and 5, which did not differ much from each other, was taken to represent the position of the bridge unloaded, the girders sustaining only the weight of the structure.

By comparison of this with the readings of No. 2. and No. 4, the effect of the load was seen, according as it was applied on the western, or the eastern bay.

The mean of these two results, therefore, expressed the deflection due to the load, as determined by actual experiment.

Finally, it was desirable to ascertain how far this practical result corroborated the theoretical deductions which had been made with respect to the bridge, and the effect of the continuity of its structure. For this purpose the deflection was computed according to the formulæ given in page 32 (Equation III.), and in the same manner as in the table, page 36; but using the altered data of the weight of the structure, and of the load applied.

The comparison of the computed and experimental results is given in the following table:—

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* In the previous experiments this weight was assumed to be 164 tons, but about 20 tons of ballast had been removed, before the last trial.

DEFLECTION of the TORKSEY BRIDGE.—Comparison of the Calculated, with the Actual Deflection, as obtained by Experiment, 28th March, 1850.

Distance from End.		Calculated Deflection due to Load.	Actual Deflection.	Difference.
		Inches.	Inches.	Inches.
End Pier	0 feet.	0·00	0·00	0·00
LOADED OPENING. (Load 144 Tons + weight of structure).	5	+0·09	+0·11	0·02
	15	0·26	0·27	0·01
	25	0·42	0·55	0·13
	35	0·52	0·56	0·04
	45	0·61	0·73	0·12
	55	0·66	0·72	0·06
	63	0·64	0·66	0·02
	75	0·61	0·64	0·03
	85	0·55	0·56	0·01
	95	0·45	0·50	0·05
	105	0·32	0·40	0·08*
	115	0·19	0·29	0·10*
	125	+0·05	+0·19	0·14*
Centre Pier	130	0·00	0·00	0·00
UNLOADED OPENING. (Weight of structure only = 145 Tons).	125	−0·06	−0·02	0·04*
	115	−0·15	−0·06	0·09*
	105	−0·22	−0·15	0·07*
	95	−0·27	−0·23	0·04
	85	−0·29	−0·25	0·04
	75	−0·30	−0·27	0·03
	65	−0·30	−0·20	0·10
	55	−0·27	−0·22	0·05
	45	−0·24	−0·16	0·08
	35	−0·19	−0·11	0·08
	25	−0·13	−0·06	0·07
	15	−0·10	−0·05	0·05
	5	−0·03	+0·03	0·06
End Pier	0	0·00	0·00	0·00

Thus the difference between the calculated and the actual deflections, was generally under one-tenth of an inch, a quantity quite within the range of errors of observation and other accidental causes; and therefore the correspondence between them was considered satisfactory.

The following extracts from a report to the Commissioners by the Inspecting-Officer, give his account of the result of the experiments: —" In order to test the value of continuity, as applied to this particular bridge, the ballast was removed from it, so as to leave a load, the weight of which could be estimated with tolerable certainty. It amounted to 144·8 tons over each opening, to which was added an evenly-distributed load of 144 tons, which was placed on each opening in succession, the deflections of each tube being observed in both experiments, at every five feet of its length. The result very nearly corresponded with theory, the greatest deflection in no case exceeding 0·15 of an inch, beyond that deduced by calculation. These experiments were made with great care, and are therefore to be fully relied on; Mr. Fowler, assisted by Messrs. Wild and Pole, having afforded every possible facility and assistance in rendering them trustworthy. Considering, therefore, the continuity of the bridge as a fully-established fact, it remains to be considered what is the greatest strain that may be brought upon any part of it in practice; and here applying the calculation submitted to the Institution of Civil Engineers in an able paper by Mr. Pole, and supposing both spans to be equally loaded with 400 tons, as stated in my former report, I find that the compression on the top plate at the point of greatest strain is 4·25 tons, and the tension on the bottom 3·91 tons per square inch; I find also that the tension on the top plate over the centre pier is 7·18 tons, and the compression on the bottom the same, these results being calculated under the supposition that the whole sectional area of the top, including plates and angle irons, is effective without any deduction for the 'diminished strength of plates joined by single rows of rivets as before described.' But in order that there may be no question as to the amount of load, it will be well to submit for the consideration of the Commissioners, similar results obtained with weights, concerning which no question can arise, as they can be made of loads in use at the present day upon railways in the kingdom, and may therefore reasonably be expected in the course of the public traffic to come upon this bridge.

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* The magnitude of these differences was ascribed to a slight degree of elasticity in the centre supports of the girder.

" Weight of permanent load as reduced by Mr. Fowler with two inches of ballast . .	164·3 tons.
Load taken as equally distributed at ½ ton per foot	173 ,,
Total . . .	337·3 tons.

"With a load of this weight upon each span, the tensile strain per square inch upon the top, and also of compression on the bottom plate of the tube over the centre pier, will be 6·06 tons; and in the case of only one train, of the weight of two-thirds of a ton per foot passing over both openings of the bridge, in consequence of the position, between the tubes, of the rails, about three-fourths of the weight of the train is carried by the tube adjoining it. The tensile strain upon the top, and compression on the bottom, will therefore amount to 5·22 tons per square inch, still exceeding the amount specified in my former report as a maximum.

"In these results, no allowance has been made for the strength of the top plate being diminished by riveting, so that it does not exceed two-thirds of its original dimensions when submitted to a tensile strain, nor of the form of the bottom, which does not correspond with that of those parts of such wrought-iron structures as have been heretofore erected, and are subjected to compression. Considering, however, that these heavy strains are upon a part of the tube which receives direct support from the masonry below, and that even though the elasticity of those points should become injured, the continuity of the tubes, would, nevertheless, as long as the power of the metal was not altogether destroyed, tend to diminish the strains upon the tubes between the supports, I am induced to recommend that the Company be permitted to use this bridge for public traffic, provided their engineer will make such an arrangement of the platform, that the ballast cannot be allowed to accumulate beyond the depth of two inches, upon which consideration was based his calculation of the weight of the structure, and also that careful tests should be applied from time to time, with occasional inspections by an officer of this department, who would report whether by the effect of traffic, the elasticity of the metal giving the effect of continuity to the bridge over the two spans remain unimpaired."

On the 6th of April the Commissioners informed the Secretary of the Manchester, Sheffield, and Lincolnshire Railway Company, that they had reconsidered the question of the propriety of allowing the line to be opened, and having received a further report on the subject of the Torksey bridge, they were willing to allow it to be used for public traffic, on being informed that the recommendations as to the ballast had been complied with, and on receiving an assurance from the company, that should it appear necessary to the Inspecting Officer, at any future period, on an examination of the bridge, that it required to be strengthened, the railway company would promptly attend to his suggestions.

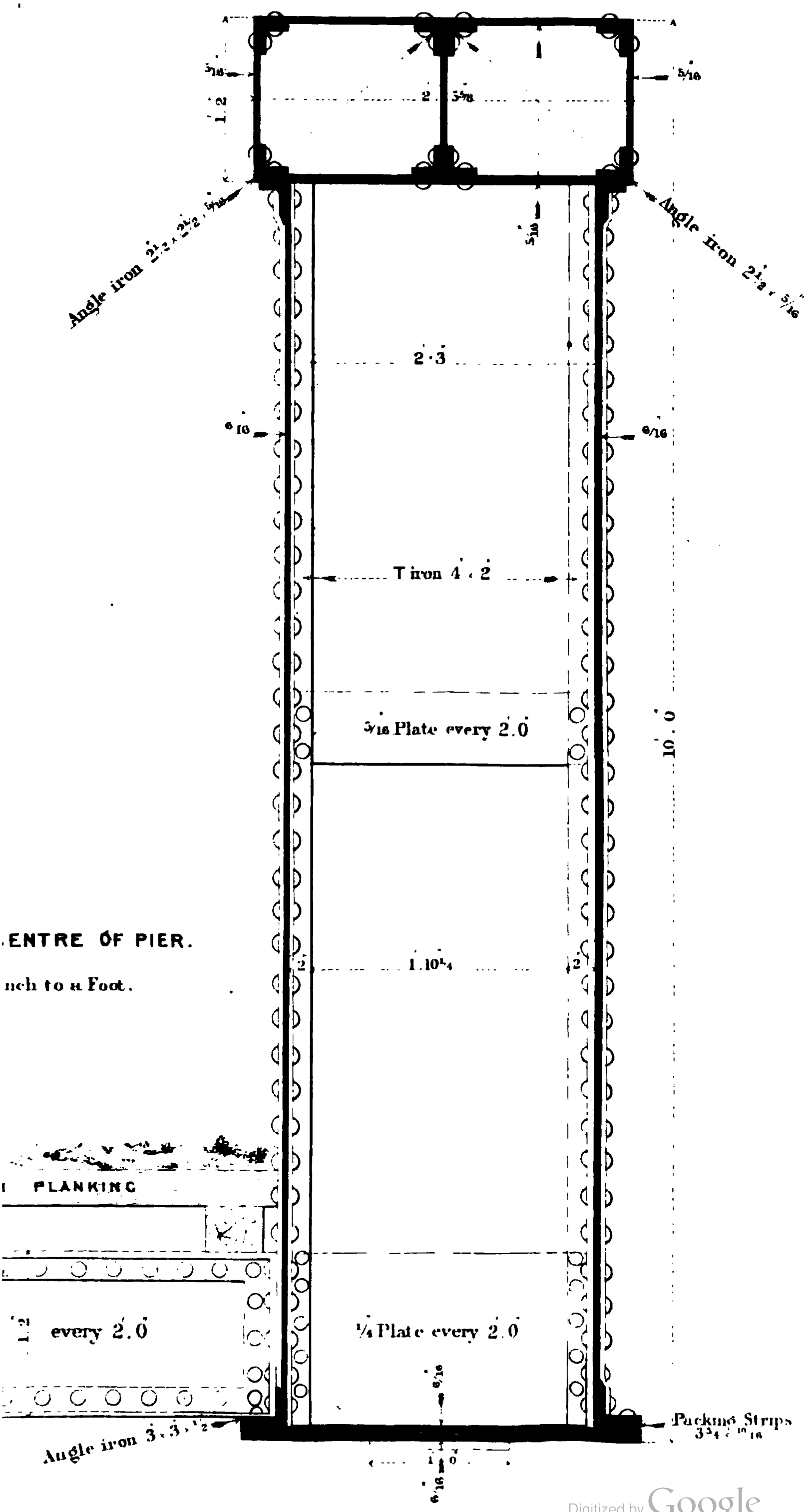
The alteration in the planking of the platform, limiting the thickness of ballast to 2 inches, as offered by Mr. Fowler (page 48), was then made, and on the 25th of April formal permission was accorded by the Commissioners for the opening of the line.

Thus had an important line of railway been arbitrarily closed for a period of upwards of four months, and a bridge been condemned as unsafe which, when examined by practical engineers, had been proved to possess ample strength, and all this in consequence of the attempt to introduce the system of centralization and of Government supervision, which was found to be so pernicious in Continental States, and the employment of officers who possessed undoubted skill for their own peculiar military duties, but who were placed in a false position when they were entrusted with the execution and control of civil works, of which their previous pursuits precluded their obtaining a practical knowledge.

SEC. INST., C.E.

LONDON: Printed by W. CLOWES and SONS, Stamford Street.

PLATE 11.



ENTRE OF PIER.

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LECTURE

ON

SANITARY REFORM.

BY

ALEXANDER THOMSON, Esq.

OF BANCHORY.

Read on 4th November, 1859, *before a Meeting of the* "ABERDEEN LADIES' AUXILIARY SANITARY ASSOCIATION," *and published by request and for behoof of the Association.*

𝔄𝔟𝔢𝔯𝔡𝔢𝔢𝔫:
GEORGE & ROBERT KING,
28, ST. NICHOLAS STREET.

1860.

SANITARY REFORM.

I HAVE been asked to address you this evening on the subject of Sanitary Reform—and I have much pleasure in doing so, especially as this meeting is in connection with the Aberdeen Ladies' Auxiliary Association—a recent addition to the many valuable social institutions existing amongst you, and from which I anticipate the most valuable results. It is especially work for female hands to do—many of its details are familiar to them though perfoundly mysterious to us men—they are at home and at ease with matters, the practical details of which we cannot easily comprehend, though we are thorougly aware of their importance, and can perfectly appreciate their results.

I am to deliver the *first* of a series of Lectures, and therefore it seems to me that I should endeavour this evening to speak mostly of general principles—knowing that others more able than myself will follow with ampler details, but not altogether avoiding them when they come naturally in my way.

My difficulty is not the want of subjects on which to speak, but because there are so many, and so distinct, which fall legitimately under the description of Sanitary Reform, that it is not easy to know how to make a selection.

Sanitary Reform embraces all measures by which the life and health of man can be preserved and prolonged—whether by great public undertakings, enforced by Acts of Parliament, and carried out by public Boards, or petty daily actions within our own homes, all having one object in view, the good sanitary condition of the community—and you must at once see that this is a matter in which we are all equally dependent on each other. The rich and the poor, by ignorance or inattention to sanitary measures, may inflict the most grievous injuries on each other, all are alike interested, and all have a duty to discharge to themselves and to their neighbours.

It has been often asserted that the perfection of human happiness consists in possessing "*a sound mind in a sound body*," and if the words be correctly understood, if we mean by them a mind at perfect peace with God, occupying a body free from pain and weakness, then the assertion is perfectly correct; but, unfortunately for us, the person who truly fulfils both conditions, who is thus equally sound in body and in mind, is not to be found; its full realization is only to be looked for in a higher and holier state of being; but it may be attained, even in this world, to a much greater extent than at present exists among us.

This expression of "a sound mind in a sound body," takes for granted that body and mind act and react upon each other; and this is a truth of vital importance in all discussions on sanitary questions, and one which must never be forgotten.

Let the *mind* be in the soundest possible state, if the body be suffering, the *man* must be in discomfort until the cause of that suffering be removed; and, in like manner, if the mind be in an unsound, unhealthy condition, above all, if there be not a felt sense of reconciliation with God through a Redeemer, no amount of health and vigour will make up a sound man. Body and mind must be equally sound before man can know all the happiness of which his complex nature is capable.

There is one great general principle on which all Sanitary Reform must be based, and it is—that soundness of mind and soundness of body are both to be derived from strict compliance with God's laws.

For our minds (meaning, by that word, all that portion of our nature which is invisible and spiritual), He has given us His laws in the Holy Scriptures.

For our bodies He has given us equally inviolable laws in all those qualities and properties which he has imprinted on the whole visible matter which He has created, and not one of which man can ever violate with impunity.

As there is no happiness worth the name which that man can enjoy who lives in the violation of God's moral laws—no safety for the soul of him who neglects the salvation offered in the Gospel—so there is no safety for the body of him who lives in the violation of God's physical laws.

As, in the moral world, man can never with impunity transgress God's law, so in the physical world God's physical laws can never be transgressed with safety; in either case the punishment—the necessary consequence—may be delayed, but is not the less sure.

Let it ever be remembered that the first step in true Sanitary Reform is to see to it that our hearts be at peace with God, through our Redeemer. Without this all else will avail us comparatively little, and that peace is freely offered to all, without money and without price.

But my business this evening is with the material or physical branch of our subject.

In sanitary matters we at once find that the highest researches of science, and the most trivial actions of daily life come into constant immediate contact with each other.

The whole of physical science is occupied by investigating the laws and properties which the Creator has impressed on the matter which He brought into existence, and not a few of its various departments have to do with sanitary studies. The researches of men into the properties of matter have been pursued from the earliest periods of history; and, in recent times, most wonderful discoveries have been made—all tending to the happiness, the health, and the comfort of mankind.

In regard to sanitary matters, there are three different classes of students to whom we are specially indebted.

1. The *Chemist*, who studies the properties of matter, and specially the action of one kind of matter upon another; who explains to us how and why bad air, bad water, bad food, act injuriously upon the human frame.

2. The *Medical Man*, who studies the diseases which afflict the human frame, and traces their causes, their history, and their progress; whether they be contagious or infectious, epidemic or local.

3. The *Statistician*, who collects every sort of information on every subject, and accumulates, in long rows of figures, facts of the greatest value. His tables may look very alarming to the uninitiated, but they are of incalculable practical value in regulating not only the laws of the nation, but also in modifying the habits of society, down even to the most trivial acts of every-day life.

Sanitary science depends on the labours of these three classes of students; and, year by year, their work is becoming of greater practical utility.

The result already is to teach us most forcibly that we do well to study accurately the physical laws by which all matter around us is governed and controlled, lest in ignorance we should be living in habitual violation of them, and thereby incurring unfailing penalties; and, also, that we shall do well to consult those statistical returns, which are, in fact, nothing but the practical proof of the consequences of conformity to or neglect of the ascertained laws of matter.

But you may be ready to say, we have not the time to spare, nor the knowledge requisite to make such investigation. Most true; but that is no good reason for your not availing yourselves of the knowledge which others have, with much pain and labour, sought out for the common good of mankind, and which experience would soon prove to you to be true.

We are all obliged to take most of our knowledge at second or third hand for the affairs of daily life. We cannot investigate every thing for ourselves; we must trust to others, and our wisdom lies in trusting to those who have most carefully studied the subject in hand, and whom we find by experience to be the most trustworthy guides.

There are three great elements or agents in Sanitary Reforms, and these are Air, Water, and Light.

Let us briefly consider each of these.

Without Air a man must die. Put a strong healthy man into a coffin, screw down the lid, and in a few minutes he is dead. This is an extreme case; it rarely happens that even in accidents a man is totally deprived of air: but if air be absolutely necessary to life, pure air, and plenty of it, are equally necessary to health and comfort.

The chemist will tell us how this is. The air we breath, as most of you know, is composed of two kinds of air, or gas, mixed together. Every 100 parts of common air contains 79 parts of a gas called nitrogen, and 21 of another called oxygen.

A man in health breathes, or inhales and exhales, air about 12 times in a minute, and each time he draws in and breaths out about 24 cubic inches of air, or about 150 or 160 cubic feet in an hour.

During the few seconds that the air remains in the lungs, a great change is effected. The greater part of the oxygen disappears, and in place of it the air breathed out is now found to contain a quantity of another air—carbonic acid gas—the same with the choke damp of coal mines.

The oxygen is the life-sustaining part of common air—by passing through the lungs a portion of it is consumed, and the air which comes out is no longer fitted to maintain life. In ordinary circumstances it is, however, largely mixed at once with the surrounding common air; and, therefore, though damaged and deteriorated, is not, at first, absolutely unfit for being again inhaled, but the oftener the process of breathing is repeated in a tolerably close apartment the worse the air becomes.

It is thus that animals, accidentally shut up in air-tight vessels, soon die. Popularly they are said to be suffocated—it would be more correct to say they are *starved*, for they are deprived of a substance which is, if possible, more necessary to life than food or drink.

Now, this includes the whole theory of ventilation or the supply of air in a pure state to the human lungs.

Many persons spend a considerable part of every twenty-four hours in circumstances which bear far too close a resemblance to being inside an air-tight vessel.

The *Box-beds*, once so common in this part of the country, and not yet altogether unknown, are far too like such a vessel, and were they only exactly constructed would be speedily fatal to the inmates. A canary bird, hung up in its cage, inside one of these beds, occupied by two or three persons, has been found dead in the morning. Can what kills a bird be good for men and women?

A room without a chimney, and with well-fitted doors and windows, all carefully closed, is not very much better; but, happily, there are, in general, abundance of chinks and cracks and openings through which fresh air enters, an unbidden but most salutary guest.

But, though few persons actually die from this cause, very many suffer most severely from it; their lungs, not supplied with the food they require cannot furnish the rest of the body with its necessary nourishment. Disease, in many various forms, attacks the weakened frame, and premature death, or a life-long want of health and vigour is the necessary result.

The greater the number of persons collected together in a given space, the more necessary is attention to this matter. Every pair of lungs is incessantly at work vitiating the air, and rendering it unfit for respiration. Unless means be taken to remove the foul air, and furnish a supply of fresh air, each person is obliged to take in air, a portion of which has already been in the lungs of another, and from which more or less of the nutritious portion has been extracted while a similar quantity of noxious air has been added.

I can appeal to your own experience in this matter. If a numerous meeting continue long, the air becomes more and more unwholesome, even in a spacious hall or church, unless the place be thoroughly ventilated. Some persons become faint —all feel exhausted and uncomfortable, and all are glad when the meeting, however interesting or important, draws to a close, and they get out to the pure air, and have their lungs filled with wholesome nourishment.

Those who have been in the meeting from its commencement feel uncomfortable, but they are not fully aware of the state of the air they are breathing. Let a man come in from the street and he is fully sensible of its foul condition.

It is the very same, on a smaller scale, with our own sleeping apartments. When the doors and windows are all closely shut for the night, all feels right and comfortable, but before morning comes, the air is thoroughly polluted and unfit for healthful respiration.

This subject has of late been very carefully studied. Many experiments have been tried, and some of them very costly, especially in ventilating the new Houses of Parliament. The expense has been great, but it is not to be grudged, for both the failures at first, and the success at last have given us invaluable knowledge.

The general principle of all ventilation is, that the foul air being heated is made lighter, and rises to the top of the apartment which contains it, and endeavours to escape, while fresh air is constantly seeking admission from below to supply its place.

In large public buildings this is now managed by very numerous small openings in the floor, or lower part of the walls, to admit the fresh air, and by larger openings in the ceiling to allow the heated air to escape, and in them the current is often increased by artificial means, such as the burning of gas. The adjoining Music Hall promises to be a most successful application of these principles.

Private dwellings, and especially sleeping rooms, must be treated on the same principles, though not admitting of the application of the same details, and the smaller any room is, in proportion to the number of its inmates, the greater care must be employed for its ventilation.

There is one kind of dwellings which no wit of man can ventilate, and that is a cellar underground, and surrounded by solid earth on all sides—no temptation should induce any family to dwell in such a place—and yet, in the great commercial city of Liverpool, a few years ago, many thousands, mostly Irish immigrants, dwelt in cellars. Their state of health became fearfully dangerous to themselves and to the neighbourhood, and at length the Legislature was obliged to interfere, and put a complete end to the system in that town.

Any room above ground, and having walls and windows to the open air, may be tolerably ventilated by a little trouble, provided always the air outside be not polluted.

We are all greatly afraid of draughts of cold air, and they are bad no doubt; they are proofs of bad ventilation. By them fresh air is conveyed to a particular spot in too great a quantity, and too suddenly, but they are not so bad as the opposite fault, and in general they soon cure themselves by bringing about an equilibrium betwixt the cool and the heated air.

Any one who goes from the fresh morning air into a small room, *not ventilated*, where several persons in health have spent the night, finds the atmosphere of it intolerably offensive, incapable of supplying his lungs with what they need, in other words *unwholesome.* This is a practical fact with which all have to do.

Every sleeping or working room ought to have openings of some kind or other, at or near the ceiling, to permit of the immediate escape of the hot half consumed air; the higher up the better, and in sleeping rooms, at all events above the level of the beds.

A chimney, with an open fire place and a brisk fire in it, is an excellent ventilator.

When the walls of a room are lathed and plastered, then a small opening cut into the space betwixt the wall and the plaster, any where near the ceiling, is most effectual, and easily done. When there is no lath and plaster, as is too common in English towns, then a perforated brick may be inserted in the outer wall—opening, of course, into the room.

Failing these self-acting appliances, the window sash may be drawn a little way down before going to sleep, and kept down all night with perfect impunity if the door be tolerably well fitted. A gentle stream of cold air will flow steadily in, and the heated air will flow out with equal steadiness and without any perceptible draft, when once experience has taught to adjust the two openings to each other. This depends on the size of the room and the number of its inmates.

A man who sleeps in a well aired room rises in the morning fresh and vigorous, ready for his work, when he who has spent the hours of repose in a close foul atmosphere gets up weak and languid, and disinclined to exertion, and, if not restrained by prudence or by principle, is very apt to fly to a morning dram, for that stimulus for which he feels a craving produced by the want of a supply of pure air to his system.

If a room be occupied by *too many persons*, be it a work-room, a bed-room, or a school-room, no ordinary means of ventilation can keep that room pure and healthful.

On this subject much information has been obtained from experience in the construction of cells of prisons, dormitories of poors' houses, wards in hospitals, and barrack rooms for troops.

The result is that to keep a healthy man in perfect vigour, he ought to have a room about 10 feet long, by 6 wide, and 8 or 10 high. Such a room contains from 400 to 500 cubic feet of air, and the dimensions ought to increase in proportion for each additional inmate.

The ventilation ought to be so managed as to cause the removal and renewal of the contents about once an hour, and this process ought to be in ceaseless action so as to be altogether imperceptible except in its results.

This statement and calculation can be easily applied to rooms of any size and form. Let it be deeply impressed on our minds that nothing can compensate to us for the want of a sufficient supply of fresh air in our rooms, and if the same room be used for every purpose, for work and for sleep, by day and by night, then it becomes doubly important.

The next great Sanitary element is *Pure Water*, and it is very little less necessary to the human frame than pure air.

Pure cold water has long been dreaded by many persons as an unpleasant, if not dangerous, application. We are become wiser in this respect than our forefathers, and it is now justly admitted by a large proportion of the population that there is nothing so salutary, so refreshing, so invigorating as pure cold water, whether applied externally or internally.

In large towns, the introduction of water for general use must be accomplished by the public; it is beyond the power of private individuals; it must be done either by Companies or by the Municipal Authorities; but the inhabitants are entitled to see that it be brought in one way or another, both of good quality and in ample quantity.

It cannot be thus brought without great outlay, and, in one form or other, that must be paid for; but if effectually done, the cost to be paid is a good bargain—the advantage is well worth the outlay.

In the present day no town-house ought to be tolerated without water on every floor, and accessible to every inhabitant.

I know no greater boon which the Municipal Authorities of a City could bestow on the inhabitants than to defray, from the common good, or in any other way, the expence of introducing water so that every inhabitant had an unlimited supply without the payment of any *special* rate for the purpose. They would reap a rich reward in the health and comfort of the citizens. It would be a first-rate Sanitary Reform.

I need not dwell to you on the uses of clean water in every household; and it is your duty and your right, as citizens, to see that you have it.

Recent enquiries have brought to light blunders almost incredible in this respect.

It has been found, in not a few cases, that the public wells of towns have been polluted by the contents of badly constructed drains and even of church-yards, and this horrible infusion of all that is most revolting has been furnished as drink to the inhabitants. In other cases water from an adjoining river is pumped up by costly machines, and a heavy tax levied in consequence, and that water taken up *below* the town, and containing a solution of all the filth of the drains. No wonder if fatal diseases prevailed in towns so supplied.

The old Romans were possessed of a wonderful amount of common sense, and they gave one strong proof of it in the matter of supplying their towns with water.

Rome stands on a very unhealthy site, but its rulers brought in vast supplies of water at great cost, and thus made it comparatively healthy and habitable. When, during the wars of the decline and fall of the Empire, the aqueducts were gradually destroyed, the city became more and more unhealthy, and the population was reduced to a few thousands. Water was again introduced, and Rome began again to prosper, and at this moment no town in Europe is so abundantly supplied; but for this, I believe, Rome would ere now have been as desolate as Babylon or Nineveh.

In this country, though not exposed to the heats and malaria which make the neighbourhood of Rome so unhealthy, yet the great accumulation of human beings, on a small space in our towns, brings about a somewhat similar state of things, and makes a proper supply of water a matter not only of prudence, but of necessity.

Aberdeen, in this respect, is very favourably situated, for either of the two large rivers which flow on its northern and southern boundaries can supply it in any quantity and at such a level as to raise it to the top of every house. The water of the DEE has been proved by the most careful investigators to be freer from impurity than that of any other stream in Britain.

The introduction of water into the town from the Dee by steam power, twenty-five or thirty years ago, proved a great boon to the inhabitants, but the quantity which can be raised by the engines is not now adequate to supply the greatly increased population, nor does it seem desirable that a large city should ever be dependent for its supply on machines which may possibly break down. It ought, in every practicable case, to be introduced on the self-acting Gravitation Principle. Glasgow has lately set a splendid example of what ought to be done. Let Aberdeen, as soon as possible, follow in the same path.

Light.—The third Sanitary Agent I named is *Light.*

Light, as a sanitary agent, has scarcely received all the attention which in truth it deserves. Both directly and indirectly, it is most important; and the highest medical authorities tell us that there are certain diseases which are produced by want of light, and which can only be cured by means of light.

But, independent of these special cases, abundance of clear daylight is absolutely necessary for the human frame. It cannot thrive without it. We all know the result of endeavouring to grow plants in the dark, or even in obscurity; how weak and feeble they are.

We see, too, the effect produced on hardy men constrained to pass many hours a day in mines, even if no choke damp or fire damp exist in them. A badly-lighted room bears no small resemblance to a mine or pit. Its aspect is most unpleasant—no person and no thing looks well in it—nothing about it looks healthy or thriving.

The recent abolition of the window tax was an admirable sanitary movement; but, unfortunately, it is not always easy to cure the effects of the tax on old buildings.

The indirect effects of want of light are not less mischievous. Light in a room is the great enemy of dirt and disorder, while darkness encourages and conceals both.

When dust and filth are not seen, there is little inducement to take the trouble of removing them, and there is a strong temptation to let them alone, from the certain knowledge that the room just looks about as well when dirty as when clean.

The light of heaven, like the air we breathe, is the gift of God to all mankind, and it ought to be freely admitted into every dwelling. In choosing a house, choose always, other things being equal, the one which is best lighted.

Some recently built manufactories, for various purposes, have fully carried out this, and are almost as light as the open air—alike to the advantage of the work and of the workers; and, now that glass has been so much reduced in price, we cannot doubt that the employment of it in buildings of every description will be greatly extended.

Regarding air, water, and light as our three great sanitary agents, we may fairly sum up the rightful employment of them all in one homely word—viz., *Cleanliness*. Without a plentiful supply of all three this cannot exist, either in our houses or in our streets.

CLEANLINESS.—There is an old proverb which tells us that "Cleanliness is next to Godliness;" and, truly, its importance can scarcely be over-estimated, either in its moral or its sanitary results.

As a sanitary matter, it must be regarded in two aspects—the one *private*, the other *public*—the one having to do with the care of the person and the interior of the house, the other being occupied with the necessary regulation of the public drains, and sewers, and streets, and courts of towns, and the immediate vicinity of houses and farm buildings in the country. The former are the personal concern of each individual; the latter, at least in towns, are more or less under the control of Acts of Parliament and public Boards.

Personal cleanliness, in all ranks of society, is admired and praised, but few persons, comparatively, are aware of its importance to health.

Every portion of the skin of the human body is full of openings visible only to the microscope. Through these openings, or pores, as they are called, a perpetual process of purification of the whole frame ought to be going on; but, if the pores be clogged, or obstructed by a coating of filth, the process is checked, and the system more or less deranged. It will give you some idea of the importance of this when I state that, in a square inch of the palm of the hand, there are 3,500 of these pores, and, on an average, about 2,800 over every inch of the body—being about 7,000,000 in number on the whole body of a person of average size.

These, in fact, are so many self-acting chimnies, constantly, but imperceptibly, at work, carrying off what must be removed from the human frame, and the quantity thrown off by the skin of a full-grown man, by means of this insensible perspiration, is somewhat more than two lbs. weight in the twenty-four hours. If this action be impeded injury must follow. Happily the best of all applications is within the reach of almost all—cold water and a hard towel daily applied, will keep the outer man in sound order. Unhappily there are many, both rich and poor, who dread cold water, and regard it as a most unpleasant if not a dangerous application. A little experience would soon persuade them that there is nothing so healthful, so strengthening, so comforting to the human frame, as pure cold water; and happily this opinion is fast gaining ground among all ranks of society.

The cleanliness of the dwelling is of nearly as much consequence as that of the person.

If a floor be covered with dust, every footstep raises a portion of it, and the smaller particles find their way through the mouth and nose to the stomach and wind-pipe, and the action of these organs is obstructed and injured by their presence—they are to them unbidden and unwelcome guests.

Many think they do well if they clean up their rooms once a-day, or, perhaps, once a-week. This will never make a nice comfortable dwelling; and, moreover, it gives much more and much harder work to do, than keeping the house always right by constant little attentions to sweeping and tidying, especially after any work which necessarily makes a mess. There are few things which a woman can do at home which add more to her husband's comfort, and thereby secure the continuance of his affections than his finding a clean comfortable room always waiting his return; and it is a work which even young children soon learn not only to do, but to delight in doing.

Every description of useless rubbish, whatever it be, ought to be removed from the dwelling at once, and if this be restrained by Police regulations in towns, to certain hours of the day, none should be allowed to accumulate within the house beyond the appointed time. All such accumulations pollute the air of the dwelling and tend to render it unfit for admission into the lungs.

In towns, however, cleanliness cannot be effectually insured for sanitary purposes by any amount of care of the person or of the interior of individual dwellings.

Great care must be bestowed on the scavenging, drainage, and sewerage of every street, and court, and corner, otherwise no amount of personal care will make a healthy town.

This is not the work of individuals but of the public, and it is one in which the whole population, rich and poor, are equally interested; and it is their mutual duty to see that it be effectually done. The expense is considerable, and the necessary rates are often much complained of; if the work be inefficiently done, the complaint is most just, but if it be thoroughly executed, the necessary rate ought to be counted an excellent bargain—for a smart attack of preventable cholera or fever, in a crowded locality, levies a far worse rate than any collector, and listens to no pleas of poverty, waits for no appeals.

It is only in modern times that the removal of noxious matters from the streets of our Scottish towns has received public attention, and become a source of municipal revenue.

It is stated, I believe correctly, that at the beginning of last century, an enterprising landed proprietor near Edinburgh was paid 4d. per cart load for each load of street refuse he was so good as to remove. The bargain continued for a number of years to the great satisfaction of the magistrates and inhabitants of our capital; and the benefits to the estate in question are apparent to this day. Towns in the present day do not treat their country neighbours so liberally. They exact a good price for the sweepings of their streets, but it is cheerfully paid, for the material is as valuable to the country as it is injurious to the town.

There is one source of disease and danger in towns which requires to be very strictly looked after—viz., the accumulation of masses of putrefying animal and vegetable matter in out-of-the-way corners. They are always offensive, and atmospheric changes, a sudden rise of temperature, or a shower of rain, may, in a few hours, change what is simply unpleasant, into what is highly dangerous.

The temptation to accumulate such matters is considerable, for they cannot be removed without trouble; but any one who becomes aware of their existence near his dwelling ought at once to complain and insist on their removal. No man is entitled to make profit at the risk of his neighbour's life or health—and many a deadly fever has originated from a fermenting ash-pit or a filthy pig-sty. We acknowledge a man's right to protect his house against intrusion, but we cannot admit of his availing himself of that privilege in order to convert any part of his house or out-buildings into a poison manufactory. The public has an undeniable right to interfere and prevent him.

These remarks apply to the removal of the solid refuse of the streets. The removal of the liquid sewerage is, if possible, still more important; and for this plain reason that the waste and soil pipes of every house being connected with and opening into the public sewers, unless these be well-constructed and in good working order, the noxious gases accumulated in them must come up into the houses and apartments of the inhabitants.

The first step here is to have the public sewers properly planned and constructed, and here, again, Aberdeen is most fortunately placed—there is no part of it which cannot be thoroughly drained.

The second, is to have an ample supply of clean water constantly passing through these drains—diluting, dissolving, and carrying off their contents.

The third question, and a very important one, is, what to do with the contents. The whole liquid sewerage of our large towns is, with some small exceptions, allowed to go to waste, or, what is far worse, to pollute the rivers and streams in the near neighbourhood of our towns; and in some cases, especially London, this is so managed as to make the water of the river wholly unfit for domestic use, and for a period of the year most dangerous to all residing within its influence.

Much has been written and spoken on this subject of late years, and there is diversity of opinion as to the pecuniary value of liquid sewerage, and as to the best modes of turning it to account; but there is no doubt as to the necessity of so arranging that it shall not be destructive to the health of the inhabitants of our towns.

One of the latest publications on the subject, by the very eminent German chemist, Liebig, goes so far as to assert that, by the careful preservation and preparation of the contents of drains of towns, the fertility of the country might be increased to an indefinite extent; at the same time, providing for the complete and constant cleansing of the towns, equally to the profit of both the town and the country populations.

During the various attacks of cholera in Britain, some extraordinary facts, in regard to the sanitary state of towns, were brought to light.

Pigs were discovered in the upper floors of lofty dwelling-houses, as well as in cellars. Ash-pits—in a high state of fermentation, giving out most noxious miasmata—were found in courts so closely surrounded by buildings that the putrid air must of necessity pass into and through every apartment. Liquid sewerage was conveyed to a short distance in pipes or drains, and then allowed to spread out in pools and poison the air around.

Now, all these things must be regulated by acts of Parliament, and carried out by municipal authorities; but it is the right of the people and their duty to give no rest to the Legislature, or to the local authorities, until they be put on a sound sanitary footing. The progress of science is daily informing us more and more correctly how it is to be done, and the gigantic works now in progress in London must, whether they fail or succeed, give, at all events, most valuable information to the country.

But unless both the public and the household arrangements in a town be such as to promote, even to enforce cleanliness, then the three great Sanitary agents, air, water, and light, can have no fair play—in other words, they cannot do their work.

I have thus endeavoured to explain to you, in familiar and general language, the principles by which sanitary measures must be guided, I must next lay before you some of the results which have been proved to arise from attention to, or neglect of these principles.

These are to be obtained from medical and statistical reports —now prepared every year with great care by public officers employed for the purpose, and which are likely to prove of incalculable value in promoting the public health.

Up to this time they must be principally taken from English tables—where the study of the subject was pursued before it was attended to in Scotland. Now, however, similar tables are prepared both north and south of the Tweed, and both English and Scotch tell one tale—that neglect of sanitary precautions, in any locality, shortens the average duration of life, and diminishes the average amount of vigorous health and strength; and to change this is the aim and object of all Sanitary Reforms.

I have no intention of inflicting upon you long arrays of figures, or intricate calculations, to prove the results of sanitary observations, but I shall select a few prominent well-established facts which cannot be misunderstood, and the application of which is obvious to all.

Soon after the practice of requiring accurate returns of births and deaths had been enforced in England, it became evident that the proportions of deaths varied greatly in different districts. To present the results in a uniform shape, tables are prepared so as to show the number of deaths which occur annually in 1,000 of a population of all ages, and also distinguishing those who die of diseases which are more or less *preventable*; that is of such diseases as are made fatal by gross violations of those Sanitary Laws which God has established, and which would, in all probability, not have been fatal had these Sanitary Laws been obeyed. In other words, had the simple elements of pure air, water, and light been abundantly employed by means of ventilation and sewerage these deaths would not have occurred.

In the healthiest country districts of England, the yearly number of deaths, per 1,000, is found to be 16; and even of these, 5 are from preventable causes, and only 11 from non-preventable. Over all England and Wales the annual deaths, per 1,000, are 23, of which 12 are from preventable causes.

In London they are 27, of which 16 are preventable. In four of the largest towns in England they are as follows:—

	Total.	Preventable	Non-Preventable
Birmingham,.............	26	15	11
Leeds,......................	31	20	11
Manchester,...............	34	22	12
Liverpool,.................	37	25	12

The proportion, therefore, of preventable deaths to the whole deaths is thus from one-half to two-thirds. This is a very bad state of matters, and the great end of all sanitary improvements is to reduce these preventable deaths to the lowest possible number.

Were the needful sanitary reforms once in full operation, those who have devoted much attention to the subject, are persuaded that the average age at death in Great Britain would be the full Scriptural age of three score and ten, while not a few by reason of more strength would attain to four score. It appears from the returns that about one hundred thousand die every year in Great Britain prematurely—one hundred thousand preventable deaths!

This is a vast public loss; and, I need hardly say, it is a cause of great private suffering and sorrow. Many of them are men and women in the prime of life; heads of families, who are dependent on them for support; and the preventable death of one individual often plunges a whole family into irretrievable poverty, to say nothing of the sorrow of the desolate hearts left to mourn and to struggle.

There is another branch of the subject, if possible, still more distressing, and that is the number of children who die at a very early age.

The returns from which I am quoting prove that, out of 100 children born in Great Britain, about 30 die under five years, and the greater part of them from preventable causes.

Children come into the world quite as well prepared to grow up to maturity as the young of any of the lower animals. Of the latter very few die, unless by violence; while in Britain, with all its boasted civilization, nearly one-third of the children born die under five, and of these a very large proportion belong to the working classes.

This does not arise from any want of affection—the poor woman loves and cherishes her offspring as dearly as the richest, perhaps more so, for they may be her only treasures—but she often takes a wrong way to show her kindness, and sacrifices her child to erroneous endeavours to promote its welfare.

Perhaps to gain a small amount of wages, greatly needed for the family, she is induced to go out to work all day long, it may be returning to meals, sometimes absent from morning to night. The industry of such a mother is commendable; her desire to add somewhat to the scanty income of the family deserves our sympathy, but she earns her wages at far too dear a rate. No amount of gain a young mother can earn will ever repay her for quitting her home during the whole or the greater part of the day. The gain is immediate, and felt every day—the penalty is paid in after years, when sickly, ill-trained, disobedient, and unattached children become the torment of their parents at the very age when they ought to be their stay and support.

Much evil to infants arises from a mother being tempted to sell to another that nourishment which belongs to her own offspring. Here the temptation is very great, but it ought to be resisted. The wealthy mother has it in her power, if need be, to have her child brought up artificially in tolerable health, but the poor woman cannot, her child is sure to suffer. This is a subject on which the highest medical authorities now speak out very strongly, as one great cause of infant mortality wherever milk-nursing prevails.

Another practice which cannot be too strongly condemned, is that of giving opiates to children. It may be kindly intended. It procures rest, but not refreshing rest, to the child; it makes a quiet room to the father when he returns from his work; it procures, what is most valuable, unbroken sleep to the parents, so that they may rise refreshed in the morning—prepared for the labours of a new day. But this also is purchased at too high a price. A child's frame is very tender and easily damaged. Nothing more injurious than opiates can be administered—the effects are often speedily fatal by disordering the functions of nature, and if not, they never fail to undermine the constitution, and lay the foundation for a life of feebleness and discomfort.

It is very true that the father and mother of a numerous family among the working-classes have a most arduous task to accomplish in striving to bring them up in health and vigour, but they ought not to seek to escape or shun, and still less to yield, to the difficulties of their position—on the contrary, they ought to face them resolutely and overcome them. They will soon discover that the greater part, and the worst of them, are not necessary, but of man's own making. That, therefore, they are preventable, and that the temporary hardships they have to bear in contending against them will be amply repaid in after life, by seeing all their little ones growing up in health and vigour around them, instead of following one after another to an early tomb.

A most remarkable proof of the fatal effects of neglecting ordinary sanitary measures in the rearing of children, was furnished in the metropolis about 100 years ago. The pauper children of London were then received into workhouses, brought up amid impure air, and general unwholesome treatment, and what was the result?—24 out of 25 died within the year, and only one survived!—or of 2800 received, 2690 died within the year, and only 110 survived—wholesale murder, from simple ignorance and carelessness. The fearful facts became known, an Act of Parliament compelled the parish officers to send the children to the country, and the annual mortality was at once reduced from 2690 to 450— still, doubtless, a very large number, but a great improvement on the previous state. Fresh air, their mother's milk, and plenty of pure water applied externally are the natural requirements of children—and on them only will they thrive.

I may give you another instance of the fatal effects of neglecting ordinary sanitary measures:—

In the Crimean war, we learn from the Blue Books, 20,800 British soldiers and sailors died. Of these, 5000 were killed or mortally wounded in action; the other 15,800 died from preventable causes—in other words, want of ordinary foresight —red tape and routine killed three times as many as the bullets of the enemy.

Great and just was the indignation of the country when this state of things gradually became known—but it seems to have been quite beyond the power of official authorities to apply a remedy. That was accomplished by a delicate, high-born lady. Florence Nightingale, an honour to her country and he sex, left country and friends, and like a true-hearted Christian woman, devoted herself to the seemingly hopeless task. Her genius, guided by the highest principle and by common sense, soon discovered the causes of the evil, and applied the needed remedies, and thus, single-handed, she accomplished what boards of naval and military officers, and of medical officers too, had proved themselves unable to do.

Great and important, however, as Miss Nightingale's labours in the Crimea were, they have proved of still greater service at home—for they have drawn public attention forcibly to the whole question of Sanitary Reform. The national feeling has been fairly roused, and we may trust will never be allowed to subside until right principles are fully carried out all over the country. They are equally applicable in a Crimean hospital, in the crowded streets of a city, in a manufactory, a poor's-house, or a solitary country cottage—and they all consist in nothing more than the introduction of abundance of fresh air, pure water, and clear daylight.

The premature deaths, however, are far from representing the whole evil produced by preventable causes.

There is still more widely spread suffering produced by preventable *diseases*, which do not end in death, but cause long feebleness and inability to work, prolonged it may be for many an year.

Sickness in the families of the wealthy causes much expense, but this matters little, while, in the working classes the effects are often ruinous. The necessary outlay is very great, even with all the benevolent appliances for sickness of Infirmaries, Dispensaries, and the like, which happily we have among us. If the father of a young family be laid on a sick bed, the whole source of supply for the daily wants of the household is at once cut off. Many a family can date their loss of temporal prosperity from the day when "Father took the Fever."

This subject has only of late attracted the necessary attention, and returns are now being made which will bring out the facts distinctly. In the meantime, we believe we are safe to say, that the amount of preventable sickness is nine or ten times greater than that of preventable deaths—probably not less than a million cases in a year in Great Britain. It has been stated that the annual waste of life and sacrifice of health in England and Wales—reduced to equivalents in pounds, shillings, and pence—is represented by the enormous sum of £13,873,931, under the heads of funerals, sickness, and labour lost. Of this sum London furnishes £2,000,000, and Lancashire £4,000,000.

Those diseases which might be prevented are chiefly of three classes—Cholera in its various modifications; Fevers of all kinds; and Rheumatism. The two first are naturally the objects of universal dread from the violence and rapidity of their action. The third class, Rheumatic affections, are less dreaded, because rarely at once destructive of life, but they most completely destroy its comfort, and diminish the power of active exertion.

The ablest and most experienced physicians assure us that these are, to a great extent, preventable diseases, and if God has in mercy put this in our power, surely we are greatly to be blamed if we neglect, either as a nation or as individuals, the means known to be effectual preventatives.

The visitations of Cholera are very appalling. Its origin is very mysterious; but this we know, that, when pursuing its deadly march from one country to another—from one city to another, it invariably seizes *first* upon those who live in habitual disregard of sanitary principles—the drunkard, the dirty in home and person, the dwellers in impure air, are its earliest victims. But it does not confine itself to them—once established in a locality, it spreads all around, striking down rich and poor —temperate and dissolute. The same is true of Typhus and other Fevers of the worst type.

Now all these diseases seem to be produced by certain modifications of the state of the atmosphere acting upon certain material substances, and if these latter do not exist, cholera or fever cannot *originate*; they may be propagated in other modes, but they will not *commence* spontaneously; and even if imported, they will soon cease to ravage.

The great support of these diseases is to be found in masses of putrifying matter, and the gases evolved by them, and especially those which come up from badly constructed drains and sink pipes in our houses and gully holes in our streets.

We all know that when we smell gas in our rooms, it is prudent to send at once for the plumber to find out the leak and get it mended, lest the house be blown up, and so whenever we find an offensive smell in our houses, it is wise to set to work and find out the cause and get it remedied, lest fever break out. It is the warning given by Providence that danger is at hand, and it is at our own risk if we neglect it.

I will give you two instances. Some years ago a wealthy family in the west-end of London are stated, in a "Blue Book," to have wished, in order to save trouble to the servants, to construct a sink with pipe from the children's apartments down to the drains below. The work was immediately executed. The children had previously been perfectly healthy, and the rooms fresh and well-aired. Presently the children became ill. The doctor pronounced the disease to be typhus—but whence could it have come? At last the new sink and pipe were mentioned and examined—and what proved to be the fact? Either in ignorance or carelessness the pipe had no *trap* at the bottom, and thus it acted as a poison pipe, drawing up and delivering in the children's rooms the putrid emanations from the great street sewer below.

The necessary remedy was at once applied, and the fever soon ceased and never returned. Here was wealth employed in introducing unintentionally the most dangerous poison to the very spot from which it would have most desired to exclude it at any cost.

Again, in the town of Windsor, fevers and choleraic diseases have of late been very prevalent. The drainage was found to be as badly arranged as possible—the obvious cause of the disease. But the Castle had a separate system of drainage of its own, all in good order, and there no case of disease appeared. All at once fever broke out in two of its dependencies—immediate examination took place—it was found that the drainage of this portion of the Castle was turned into the common sewers of the town, and did not form part of the Castle drainage.

This case, so instructive, is given at full length in the Privy Council Report on Public Health for last year. In the town of Windsor the drainage matters were so arranged that the foul air of the sewers was delivered into the rooms in the higher part of the town—no wonder if it proved unhealthy.

Chemical science has been at work on this subject. Quantities of putrifying matter from the streets have been subjected to certain processes, and the *essence* extracted, in the form of a disgusting looking viscous fluid. Now, this may be termed, "essence of putrid fever," for if a minute portion of it be inserted into the veins of any animal, or if the vapour of it be inhaled by the nostrils, that animal soon dies, with all the symptoms of the worst fever.

This poison may also be obtained from the air of fever wards, or of crowded lodging-houses, or in the country from marshy bogs, where a large quantity of vegetable matter is rotting in the sun.

Now, this chemical process is merely doing in the laboratory what is daily going on, with more or less intensity, wherever masses of putrifying matter are allowed to accumulate.

Dr. Southwood Smith, one of the very highest authorities on the subject, writes,—"By varying the intensity and dose of the poison thus obtained, it is possible to produce fever of any type, endowed with almost any degree of mortal power."

The whole subject of "Fever Poisons" has been admirably discussed, in four tracts, by Dr. Robert Pairman of Biggar, and these I would earnestly recommend to your perusal. A few copies are placed in the hands of the Ladies' Committee for distribution.

Medical men have invented a new name for the fevers produced in this manner. It is not a pleasant name, but it is very expressive; they call them *Filth Fevers*, and they tell us that they cause 18,000 preventable deaths in Britain every year.

There is a time when Sanitary Reforms are most popular. When cholera has broken out, or is seen to be approaching, when pestilential fevers are raging in our crowded streets, then every voice is raised in favour of the most vigorous measures; but it is often too late, and the very cleansings which are effected of cess pools and dung pits prove fatal to those employed in the work, or to those who are exposed to their effluvia.

True Sanitary Reform consists not in sudden spasmodic fits of cleansing, but in constant daily operations, so that there never shall be any need for great works, and this is the point to which we should strive to attain.

All classes are equally interested in it. Fever may be generated in an obscure close, or a dirty lane, and its inhabitants may be the first victims, but it does not confine itself to such localities; it may originate there, but the poison spreads, and the rich become its victims as well as the poor. They have acted together in defiance of immutable laws, and they are necessarily punished together. The right object of all sanitary legislation is to oblige all the members of the community to do what is needful for the common safety.

It is a mistake to suppose that the homes of the poor are the only depositaries of filth in our towns. When sanitary measures were enforced in Edinburgh, on the first approach of cholera, it was asserted, and I believe truly, that the worst accumulations were found, not in the closes of the High Street, the Canongate, and the Cowgate, but in the lower regions of some of the first-class houses of the new town. Whatever sanitary regulations we may have, they must be equally applied to all classes. It is not fair to search into the recesses of the poor man's house, and leave his richer neighbour's house alone. No man, be he rich or poor, has any right to convert a portion of his dwelling into a manufactory of fever poisons, any more than he has to keep half-a-dozen casks of gunpowder round his kitchen fire; doubtless, he runs the greatest risk himself, but his neighbours' risk is not much less; and, if men will be so wrong-headed as to despise their own and their neighbour's safety, the public has a right to interfere, and cause them to act with due due regard to both.

It may, however, be said, How can a working man's family attend to all these things? the houses occupied by them are such as to make it impossible.

Practically, I regard this as the essence of the whole question. The houses of the working classes are too often not what they ought to be—either in town or country.

Who is to blame for this? and how is it to be remedied?

Various interests, and these apparently conflicting and rival interests are involved.

It is the natural desire of the house proprietor, whether in town or country, to draw the most rent he can for the smallest amount of accommodation, and it is equally the natural wish of the prudent working man to pay as little as possible for the necessary accommodation of his family, and these two combined have brought down the dwellings of the industrious classes to their present low level.

Many schemes have been proposed to remedy this, but hitherto with only very small, or rather, very limited success.

Model Lodging Houses have been built, and they have done great good—showing what accommodation for working men ought to be—but, in general, they have not been remunerative to the builders.

Improved Lodging-Houses also have been formed out of old dwellings, and this has proved a better money speculation, but the lodgings themselves are very inferior to new erections.

Attempts also have been made to erect dwellings—half on charity, half for a return—good houses, to be let at a rent below what would be a fair return for the outlay. This is very kindly meant, but it can never be so extended as to supply the general wants of the country; and, even if it could, I doubt much if the manly spirit of our working men would not repudiate the idea of being partly indebted to charity for their dwellings.

The real difficulty lies in the want of a right understanding between the wealthy and the working classes.

There is abundance of capital in the country to erect good accommodation for our working classes, as proved by the hundreds of millions of pounds invested in railway works in the last thirty years, in the hope of procuring a high return. But capital is a very timid thing, unless under the excitement of some mania, and, unfortunately for the working people, no mania for erecting dwellings for them has yet prevailed.

The vast capital spent in railways is stated to produce, on the whole, less than 4 per cent. per annum.

Now, if the working men can satisfy the rich men that they will get a better return than this, on as good security, by building houses, then assuredly capital will be thus employed.

It is looking for investments—it cares not what they are, provided the return be good and sure. Working men ought very seriously to consider the question of House Rent. The dearest house a family can occupy is an unhealthy insufficient dwelling, however low the rent may be. The cost of a few weeks of illness of the father, or of the sickness and death of a child, might often be spared by renting a better house.

Nor can parents be too careful in making every exertion to have a sufficient number of separate rooms for themselves and for their children. It is impossible for them to bring up children aright, unless the sexes be separated from an early age; it is equally impossible to carry out sanitary arrangements effectively, especially in cases of sickness, unless a *family* have several separate rooms.

One great sanitary evil in all our large towns is the piling of one floor on the top of another to the number of six, or eight, or even more, and even some newly erected model lodgings err in this direction. It is almost imposssible to have such great masses of buildings filled with human beings without collecting an impure, unwholesome atmosphere within and around them.

The immediate cause is the *cost* of building ground within our cities, and the obvious remedy is for people to seek for their dwellings farther from the great centres of business and work. This has its disadvantages, but they seem to be greatly exaggerated, and that the benefits would be unspeakable. The wealthier, and even the middling classes, in all our towns, are acting largely upon the plan of residing at a considerable distance from their places of business, and I can see no reason why the working population should not follow their example.

Many gentlemen engaged in business in towns, now reside with their families, 20, or 30, or even 40 miles away from the din and dust of the cities; and it costs them less time to travel by rail to their places of business every day than it did before, by omnibus or on foot, while they more than pay for their travelling expenses by their lower house rent, and have the benefit of fresh air for more than half the day.

Now, in a smaller way, working-men may do the same. If beyond a walking distance, the various lines of railway, entering every town, will carry them at a small expenditure of time and money—and they would save enough in ground rent alone to meet the expense, to say nothing of health and comfort, and many moral benefits to their children.

This is one of the advantages to be yet derived from the more full developement of the railway system.

There is an article upon this subject in the last *Aberdeen Herald* well worth your attentive perusal, founded on a paper, lately read in London, by the able Member for this City, Colonel Sykes.

I must not enter fully into this subject, my time is nearly exhausted; but it is one of the greatest importance—which has long engaged my attention—as lying at the very foundation of the prosperity of our country—for if the masses be badly *lodged*, innumerable daily evils must ensue, which no laws, no appliances, can cure.

I would earnestly press on the men and women of the working-classes what additional comforts they could procure in the shape of *homes* if they would only abandon for ever the use of strong drink, which can do them no good, and may destroy them soul and body. The outlay for drink, of even a *moderate* drinker, would pay the rent and rates of an excellent house. Besides, rich men will readily invest capital to be paid for by sober men, but they will not trust the drinking man if they can possibly help it; and this, the uncertain payment of rent, is after all the real reason why working-men find so few good houses built for their use. Put it to yourselves—Would any of you who had saved £100 by hard industry, willingly invest it in purchasing a house, and then let it to a man on whose payment of rent you could not depend? This is the true reason why money is not spent by the wealthy in erecting houses for the working-classes.

If all things were as they ought to be, then every family of the working classes would inhabit a detached dwelling, and, if in the country, surrounded by a garden, with no neighbours above or below, and fresh air flowing freely around. With the present rapid advance of discoveries, all tending in this direction, there seems no reason why another generation should pass away before a large proportion of them are so accommodated. Capital would find in it a sure investment, and Christian Philanthropy would have abundant cause to rejoice in the removal of some of the greatest obstacles to the progress of religion in our land.

I am not able to do more than allude very briefly to the sanitary results of the drinking habits of our country. This would have required for itself a whole lecture, or more than one, and it will be furnished, I doubt not, by some of those who are to follow me.

No facts are more thoroughly established by science than the absolutely deleterious effects of alcoholic liquids on the human frame, except in cases of disease, and even then to be administered with great caution. Some poisons are termed by medical men *cumulative*, because they and their effects gradually accumulate in the human frame, until at last the application of a multitude of small doses produces an effect, different it may be, but as fatal as a large quantity taken at once. So with the habitual use of intoxicating liquors—the whole framework of the body is gradually changed—and it becomes the very food on which cholera and fever delight to riot. Remember that this is just another example of the unfailing penalty incurred by violating the laws impressed by our Creator upon our mortal frames. The strictest temperance must be the foundation of all Sanitary Reform.

We are promised two or three Parliamentary Reform Bills next session of Parliament. I hope, from amongst them, a satisfactory measure may be passed; but I would much rather have a thorough good Sanitary Reform Bill, one which would procure for every family pure air, pure water, and plenty of them, and comfortable cheerful houses to dwell in. Such a reform would indeed be a radical reform. It would injure none, it would benefit all; and it is one which all parties in the State may cordially combine to procure.

The remarks this evening have been confined to the physi-cal and material aspects of the subject of Sanitary Reform—but this part of the work, though most important in itself, must not be *overvalued.*

However useful in its place, it is not the *one thing needful.* Attention to sanitary precautions will, by God's blessing, save many bodies from sickness and from temporal death, but they can save no souls from eternal death.

Nothing on this earth will prosper which is not based on true vital religion, and this is as true of our present subject as of any other. No community can be in a good sanitary state where this is wanting.

Had time permitted, it would have been profitable to have enlarged somewhat on this.

True heartfelt religion ever appears in the life and conduct. No converted man is a drunkard or licentious, or neglectful of his wife and children, and, specially, his religion will appear in his denying self for the good of others. Self-denial is an impracticable lesson to the unconverted man, but it is one of the first and most enduring fruits of the Holy Spirit after conversion, and it is the grace which is most required and most exercised in the family, and there it produces its most precious fruits, and these soon appear in what are commonly counted trifles, though in truth they are not so.

Real Christianity influences every portion of the daily conduct down to the most minute.

Can you imagine such a thing as a *dirty* Christian woman? Is it not a contradiction in terms? The Christian woman feels that her body is God's creation, and that she is bound to glorify God in her body and in her soul, both of which are his. Look around you, and you will soon remember instance after instance where the entrance of God's Spirit into a heart was followed by the instant reformation of all that was disorderly in the house and the person.

It is matter of hearty congratulation to us all that the ladies of Aberdeen have now formed themselves into an Auxiliary Sanitary Association, and we owe our special thanks to her—a stranger, who came here attracted by the late meeting of the British Association, and laid the foundation of this new Society.

We have very many valuable institutions in Aberdeen; and, perhaps, we are apt to pride ourselves *a very little* upon them; but, certainly, the want of a Ladies' Sanitary Association was a great defect.

I doubt not the same energy which enables the Aberdeen ladies to manage other institutions so successfully will be applied by them to this also.

It is an eminently practical work. The ladies will be able to carry their own knowledge and their own home experience to the houses of their hard-working neighbours, and teach them many a precious lesson in the management of themselves, their houses, and their children.

This will produce and foster that kindly feeling betwixt the various classes of society, on which our happiness as a people so greatly depends. When the rich come to know the poor, they learn not to despise them; and when the poor come to know the rich, they learn not to envy them. Both discover that God in His Providence has made much less difference in regard to earthly happiness betwixt one rank and another than is generally supposed.

Above all, I am confident the ladies will not leave their Christianity at home when they go out on this work. If Christian principle go not with them, their work cannot prosper —with it, it cannot fail.

The richest cannot purchase eternal life, they must receive it as God's free, unmerited gift, through our Redeemer; and the poorest may well rejoice to know that the Water of Life is offered to them without money and without price.

I regard the Sanitary Association as simply a new, additional and much needed branch of home mission work; and I trust that God will guide and bless all concerned in carrying it out, and greatly prosper them in their work.

ABERDEEN: PRINTED AT THE "FREE PRESS" OFFICE, BY A. KING & CO.

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THE

DRY EARTH SYSTEM.

BY

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Our attention was first directed to the Dry Earth System at an early stage of its progress. By degrees we became fully persuaded of its soundness and efficiency. We have since that time carefully watched and assisted in its further development. And we now issue the following pages in the belief that they contain a fair and moderate statement of its claims and professions.

H. J. & J. W. GIRDLESTONE.

37, Norfolk Street, Strand.

THE DRY EARTH SYSTEM.

Introductory.

The following pages are intended to supply a distinct and trustworthy statement in explanation of the Dry Earth System. It is projected to furnish a brief account of the claims and professions of that system, of the principles on which it is based, and the limits and conditions that affect its operations. And, by way of necessary illustration, some information will also be supplied on what has already been achieved by the system. One thing, and one only, need be asked as a preliminary, and that is, that the question be not prejudged. The most sanguine investigators, whether as theorists or practical men, of the sewerage problems still awaiting solution, will admit that matters are not yet clear and simple enough to justify the exclusion of any new agency, because it is new. The system now about to be described is not put forward as an infallible panacea for the social grievances which it operates upon. It is, however, only fair to ask on its behalf, as on that of any other social claimant, that it shall not be condemned unheard in respect of the claims which it does urge; and this is a demand which we are confident will not be refused by the English public.

Principles of the earth system.

The Dry Earth System may be defined to be a method by which surface earth, under certain simple conditions, is applied to the absorption and deodorization of excrementitious matter. By a long series of experiments the following facts have been tested and re-tested, and at length completely established as principles:—

1. That any surface earth, and almost any clay, will deodorize excrementitious matter, but that sand and chalk will not.
2. That such earth, if dried and sifted, has such power of absorption that it is capable of receiving both liquid and solid excreta, and of rendering their removal practicable without offence, and also without any loss in the value of the manure.
3. That a very small quantity of earth is required, and that the same portion of earth may be repeatedly used with the same effect.
4. That the action of the earth on the excreta is immediate, all fermentation being prevented, the obnoxious agent being dealt with at once and in detail.
5. That, while the earth absorbs the excreta, they in their turn possess a decomposing power such that any extraneous matter deposited with them disappears in a short time.
6. That the absorption and deodorization of the excreta result in preventing infection.

Now, the soundness of these principles rests, as has already been said, on a vast amount of evidence, furnished by repeated experiment. Varieties of climate and soil will clearly introduce slight varieties into the operation of the system; but these are matters of detail, not of principle. Every new application of the system only confirms the belief that it may ere long take its place as the most effective agency that can be brought to bear against the enormous difficulties of sanitary improvement.

The defects of the ordinary domestic accommodation for sanitary purposes, on the systems at present most usual both in towns and country districts; the expensive design, and the frequently inadequate execution outside the house itself, of the sewer with which it has to be connected; and, more than all, the dangerous, injurious, and (in certain quarters) the increasing pollution of rivers—these are commonplaces with everyone who has reflected even on the surface of the questions involved. It is now contended that the Dry Earth System will effectually help to grapple with and remove the formidable difficulties which at present so often bar the way to permanent conditions of health. Its operation is final and complete. There is no expensive machinery requisite for removal or transit to a distant spot, at which spot fresh problems of difficulty spring up again; for, in working the Dry Earth System, the whole of the transaction subsequent to the operation of the earth may be converted into a matter of profit. It is in any case a matter of ease and simplicity, unattended by anything noisome or offensive; and it may be converted, we repeat, into a matter of highly developed profit. (?)

Difficulties arising from its simplicity.

The system obviously has, and will have, to encounter a double difficulty arising from the very simple character of its basis and principles. There is, first, the prejudice to be encountered which naturally attaches to any very simple remedy for any very complex grievance, until the remedy proposed has won its way to general acceptance, and has grown customary and familiar. On reflection, it will be felt and acknowledged that nearly every valuable discovery in modern social economy has had to encounter the same prejudice and for similar reasons. The application of steam to locomotive uses, and of the electric fluid to the transmission of news, depended on natural laws which were simple and obvious; and in either case a long and vigorous course of opposition had to be met and overcome. But in the case of the Dry Earth method of Sewage, there is a danger of another kind, arising also directly from the simplicity of its groundwork. The conditions of application of the earth being obvious, they are liable on a first experience to be carried out with carelessness or inefficiency.

Either the earth is not dry, or it is irregularly applied, or it is allowed to be acted upon by other substances than the human excreta with which it has to deal. All cases, without exception, that have been submitted to examination, in which some imperfection of the earth agency has been reported, have been distinctly and directly traced to faulty application in one or more of these respects.

Various fields of operation.

It will be clear to any practical investigator of sanitary subjects that the fields of possible operation open to the Dry Earth System are very various. There is, for instance, the important sphere created by large institutions, such as Asylums, Gaols, Reformatories, and Schools. There is, next, its application in country districts, whether in the large dwelling-houses of the owners of property, or in the cottages of their labouring population. And last, but not least, come the towns. On each and all of these possible aréas of application we shall have something to say; for, fortunately, the Dry Earth System is not now claiming public attention as a new and untried *modus operandi.* It cannot be too often repeated that it has at its back a mass of practical evidence, sound in nature and constantly increasing in quantity. It has also undergone the tests, and received the decision, of a large number of practical men, whose partial approval in some cases is no less important than the unqualified approbation given in others. For it is obvious that commercial interests in certain quarters, and elesewhere the opinions to which men of science and ability have become wedded after a great amount of labour and investigation, must necessarily present formidable obstacles in the way of a system the principal features of which are its simplicity and its inexpensive character. These are obstacles, and they will unavoidably be so to a greater or less degree wherever they exist, not only to the reception of the Dry Earth System, but even to a fair and candid consideration of its claims. And hence we repeat that this is a case where even a

Nature of evidence in its favour.

partial approval carries more than usual weight, and where an unqualified acceptance is doubly significant.

I.

The system as applied to institutions, in camp, and in India.

We will now proceed to enumerate a few of the important cases in which the System has been successfully applied on an extended scale. The largest asylum in which it has been carried out is the Convict Lunatic Asylum at Broadmoor, Berks, where upwards of sixty earth-closets are now in use, and more are about to be fitted. This building was originally supplied throughout with water-closets, and the whole of the drainage was carried out under Mr. Menzies' direction and on his system. It was found, however, that these appliances were a constant source of expense and annoyance; and recourse was had accordingly to the Dry Earth System. The necessary measures were taken under the superintendence of the Clerk of Works, and the Government's own workmen were employed. The sulliage is still passed through the drains laid down by Mr. Menzies, and it irrigates some grass lands in the adjacent valleys. The whole of the ashes in the asylum are used in conjunction with the earth, which is dried on a kiln built for the purpose. The simplicity and completeness of the system are admirably illustrated in this establishment, and are well worthy the attention of those who, while admitting the main principles and beneficial results of Dry Earth conservancy, labour at the same time under an impression that its working is a matter of difficulty and complication. Broadmoor proves the exact opposite of this apprehension, and the experience there obtained is on a scale quite large enough to be conclusive. The ashes mentioned above are sifted, and the cinders thereby obtained are the only fuel required for drying the earth in the most efficient manner. No difficulty whatever is experienced in carrying out these details, and the valuable manure thus

Broadmoor.

obtained is employed on the farm attached to the asylum. It may be mentioned that the pluvial waters are not allowed to enter the drains, but are carried off by separate pipes into a large pond.

Reading.

The Reading Union Workhouse is another establishment where the system has been put into operation by the advice of Mr. Baldwin Latham, and in which it works with complete success.

Dorset County School.

In the Dorset County School, an institution at present situated within the town of Dorchester, the Dry Earth System has been in operation for more than three years. The ordinary system previously employed had resulted in trouble and annoyance perpetually recurring. In this school the every-day working of the Earth System has been found equally commodious and economical, and particular testimony has been furnished by the head master in regard to the complete success attending the removal of the earth from the premises. It is worthy of attention that the *locale* of this large establishment is about to be removed from the county town itself to a site about a mile and a half distant; and that ample provision for the working of the earth system has been made an integral portion of the design for the new buildings.

Oscott and Isle of Man.

At St. Mary's College, Oscott, near Birmingham, an important and carefully worked institution of long standing, the system has also been for a considerable time in operation, and extremely satisfactory accounts of its working are received from thence. Similar reports have been sent from the Manx Lunatic Asylum, Isle of Man, and from many union workhouses and factories, both in England and Ireland, besides the important one of Reading, mentioned above.

Wimbledon.

It was at the Volunteer Camp during the Wimbledon Meeting of 1868 that the earth system underwent what has, perhaps, been hitherto its severest ordeal, and achieved its greatest success. An unqualified testimonial was given by the

Surgeon-Major in his Medical Report on the Meeting. The whole of the leading daily papers corroborated his testimony, and from a large collection of such documents as they have supplied, the accounts to be found in the *Times* and the *Lancet* are too important to be omitted. They are accordingly here subjoined:—

FROM THE "TIMES," JULY 24, 1868.

"It would be doing an injustice to one of the greatest improvements introduced by the Association at the present meeting, if mention were not made of the excellent working of the Moule, or dry-earth system, as the basis of the sanitary arrangements of the camp. Hitherto, chloride of lime, flushing, and various other expedients have been resorted to, and have worked more or less successfully, but always with drawbacks of a too obvious character. This year the increased numbers in camp, and the fearfully trying heat, would have found out the weak places of a water system, and possibly have proved a source of danger as well. The Moule system, on the contrary, after the severe ordeal to which it has been exposed, has come out triumphant. The building where it is at work has been frequently visited by members of the Council and by officers of the Staff, and at no time could anything disagreeable be discovered. That more than 2000 men—Regulars, Volunteers, &c.—should live in camp, and that there should be absolutely no annoyance of any kind, after a fortnight of such weather as there has recently been, is a fact of which it is impossible to exaggerate the importance."

FROM THE "LANCET," AUGUST 1, 1868.

"The strongest possible testimony has been borne to the efficacy of the "dry-earth system," which was in use throughout the Volunteer encampment at Wimbledon. Last year the system was experimentally tried, and resulted so satisfactorily, that it was determined to adopt it this year exclusively. There can be no question that the test to which the system has thus been subjected was a crucial one, considering especially the excessive heat, which, although favourable to the rapid drying of the soil, was yet creative of other conditions increasing the difficulties attendant on fæcal deodorization. Altogether, some 148 dry-earth closets and urinals were in operation at Wimbledon, and when it is remembered that about forty or fifty of these closets were used daily by not less than 2000 men without the slightest annoyance to sight or smell, the measure of success is complete. It is not too much to say that no other system is possible at Wimbledon, where circumstances have all to be made to square with a temporary requirement. But if the dry-earth closets can stand the test of such repeated use as they have lately had, it seems to us to follow as a matter of course, that they must be in every way suitable for the exigencies of rural districts.

"That the system is destined to make great and rapid progress we cannot doubt, especially as by the Sanitary Act (1868) Amendment Act, which has passed through both Houses, it is provided that 'any enactment of any Act of Parliament in force in any place requiring the construction of a water-closet shall, with the approval of the local authority, be satisfied by the construction of an earth-closet, or other place for the reception and deodorization of fæcal matter, made and used in accordance with any regulation from time to time issued by the local authority.' The earth-closet, in fact, is to become a legalised 'institution,' on a par with the water-closet, and local authorities will have now the power of adopting which of the two systems they please."*

The actual number of closets in the Camp was 108, and of urinals 46; the aggregate number of volunteers was 2300, and the number of visitors admitted to the grounds, according to the published returns, reached 34,792. Yet, although this was the first occasion of an application of the system on so large a scale, and notwithstanding the unusual heat of the weather, the experiment was pronounced on all hands to be a decided and complete success. When we have added that no difficulty whatever was met with in procuring a supply of earth, nor in conducting certain cases of necessary removal, we think that sufficient ground has been given for asserting that the applicability of the earth system to camps has been substantiated beyond doubt.

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* With these selected opinions from the press should be read the letters (quoted page 14) of Colonel Colville and Captain Drake, R.E., the Camp Commandant and the Engineer Officer at Wimbledon.

Controversy arising out of the Wimbledon meeting.

This will be the proper place to mention, and, as we hope, to dispel, an apprehension which has lately been expressed respecting the Earth System, and which, if it could be shown to rest on valid grounds, would bar the way *in limine* to its adoption. It so happened that the Camp at Wimbledon during the meeting of 1868 was not free from attacks of diarrhœa. Certainly no advocate of the Earth System was ever sanguine enough to entertain the belief that the Volunteers would gain, by its adoption, a complete immunity from such forms of disease; and the extraordinary and long-continued heat rendered it more than probable that attacks of the kind would prevail pretty widely.* There was scarcely a district in England at the time where similar symptoms were not in some degree becoming apparent, and there was no conceivable reason why the Camp itself should remain exempt. Accordingly, on the appearance of diarrhœa, it was the most natural thing possible that persons who were not convinced of the soundness of the Earth System, and who entertained opinions or prejudices against its adoption, should connect this particular form of disease, not with the hot weather and the various unhealthy circumstances arising from that source, but with the application of the new method. Nothing of this kind appeared at the time, so as to qualify, as it would have been natural to expect that it would do, the universal verdict of approval. Since the meeting, however, the suggestion has been made, that while the Earth System deodorizes it does not at the same time ensure disinfection. And the specious, but (we venture to submit) the entirely delusive analogy of the rattlesnake has been brought into play. This analogy is so specious, and so neat, that it is almost a matter of regret to expose it; but it is so singularly delusive, that no one will hear without surprise of its having originated with a man of scientific knowledge and experience. What is alleged is this: that "a rattlesnake is none the less dangerous because its rattle is removed; and that, for anything shown or known to the contrary, odour is to infection, deodorization is to disinfection, what the noise of the serpent is to its bite."

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* See Captain Drake's letter, p. 15.

Earth prevents infection,

Now, it cannot be too often, or too emphatically and distinctly stated, that, although deodorization is secured by the Dry Earth System, deodorization is not its main object, nor its prime achievement. The Earth System absorbs and completely disintegrates, and practically annihilates, the substances with which it deals; and deodorization, though a necessary and a very valuable concomitant, is no more than a concomitant of these processes. Hence, as it has been ably observed, the Earth System does not content itself with destroying the "rattle" of the snake, but it lays hold of the snake itself, and either strangles him in his birth, or tears him into a thousand atoms. It achieves this result by absorption, by causing the entire absence of fermentation, and by the most minute disintegration. All vapour or gases exhaled by the obnoxious substances are completely taken into the earth covering it; and the finer the earth, the more entire is the interpenetration. So complete is the result, that the interpenetrated substance may remain where it is deposited, in the same innocuous state, for several weeks or months. Or if it is immediately removed and suffered to lie together, under cover, for four or five weeks, it may be dried without any sort of injury or offensiveness. And when the drying process is finished, the same substance may be safely transported to any distance, and handed over to the gardener or farmer, on whatever soil he may be engaged, as a valuable manure. Nor is it of possibilities only that we are speaking, but of actual facts, repeatedly performed and minutely tested.

when it is applied, not in the mass, but in detail.

In order to be captivated by the fallacious analogy of the snake, an investigator must still be labouring under a false impression with regard to the Dry Earth System. The mistake of which we speak is found to be a constantly recurring one, and is so difficult to eradicate, not only from the conception of ordinary persons, but of scientific investigators also, that we must not pass it over in silence. It has been from the first, and it still is, erroneously supposed that the Earth System claims to deal with obnoxious matter *in the mass*. So far from this being the true state of the case, it should be distinctly grasped that any such claim would strike at the very basis of the system. Universal experience has shown that to deal effectually with the mischief in question by means of earth, *in the mass*, is a matter of almost entire impossibility. Such an attempt would at any rate be attended by risks not less than those which are being daily proved to beset the older methods. But the very first law and fundamental condition of the dry system is, that the substances shall be dealt with *at once* and *in detail*. It is this condition, and this alone, which renders certain the valuable results which have in so many cases been achieved; on this depend deodorization, absorption, and innocuous removal, the detailed application being in all cases presupposed to be of earth fairly and thoroughly *dried*. And it is this essential condition which is left out of sight, when fears are expressed about the injurious results to health that may be apprehended from the fæcal impregnation of soils. The very basis of the Earth System renders any such fear not only improbable, but impossible. And the question between earth and water has, therefore, been truly and ably stated to lie between "a system which, if rightly worked, does deodorize and prevent infection, and a system which cannot deodorize and does not pretend to prevent infection."

Evidence of Colonel Colville and Captain Drake, R.E.

This controversy has called forth an expression of opinion from several of the officers who had charge of the Wimbledon camp, including its sanitary arrangements. Lieutenant-Colonel W. G. Colville, Camp Commandant, writes thus :—

Colonel Colville.

"There can have been no doubt of the success of the Earth Closets at Wimbledon in 1867.

"In 1868 the trial they underwent was a far more severe one, and on the whole, I consider they stood it extremely well.

"Certainly, under no other system could latrines have been suffered at all in the midst of closely pitched tents."

The operation of emptying some of the latrines "was performed in the middle of the night, without (as far as I could ascertain) the knowledge of the occupants of the surrounding tents—a rather remarkable fact. . . . .

"I am strongly of opinion that bearing in mind the necessity at Wimbledon of having the latrines so near the tents, under no other system would the camp have been so healthy.

"I have a vivid remembrance of the offensiveness of the latrines in 1865, 1866, and should be sorry that such a state of things should recur."

Captain Drake, in a letter addressed to the *Lancet*, and dated April 22, 1869, gives the following remarkable evidence :—

Captain Drake, R.E.

"I have been engineer officer in charge of the works at Wimbledon for the last seven years, and the sanitary arrangements have always been my principal source of anxiety. The difficulties are—an increasing number of men, very limited space, no drainage, no money to lay drainage or place to drain into, no out of the way place which is not open to view of sight-seers, water at four feet from the surface, the necessity for appearance, &c. . . . . . Open latrines and water-closets then would not—in fact did not—succeed. As far as I know, there remains but the earth system, and that did succeed. . . . . . We tried one latrine in 1867. This was built in an out of the way place, and it was very much used, volunteers going to it from all parts of the camp, and telling me that they did so because it was superior to the water closets nearer to them.

"In 1868, then, Moule and Co. erected all the latrines. These latrines were constantly inspected by the medical officers, by the camp commandant, by persons sent by me, and by myself. They worked well, were well tended by the servants of the Company, had very little smell, and that little was cured by the use of carbolic acid in the passages. . . .

"Some of the latrines were emptied during the meeting, without any inconvenience being felt. Could this have been done had any other system been used? . . . . .

"As to diarrhœa, I suspect the amount of trash consumed under the name of 'coolers,' the fruit, the beer, and the great heat had more to do with causing it than the dry-earth system of sewage. I have been a good deal under canvas, and I never knew a camp in hot weather without diarrhœa; and it is my firm belief that had the dry-earth system not been used last year, we should have had fever, if not cholera, in the camp. . . . . .

"Certainly it would be impossible to give the system a severer trial than at Wimbledon."

These two letters speak for themselves; and, when taken in conjunction with the unofficial, but decided and unanimous, reports of the press, they form a concurrence of varied testimony which is not often met with in support of a comparatively new agency.

Application in India.

It was in the year 1863 that Dr. Mouat, Inspector-General of Gaols in India, first resolved on calling in the aid of the Dry Earth System towards the reform of some of the abuses and inconveniences to which the Indian gaols had long been subject. His attention had been arrested by a paper read before the Society of Arts by the inventor of the dry conservancy system, Rev. Henry Moule, whose name has now become associated permanently with it. That paper was soon afterwards published and circulated throughout the whole of the three Presidencies by order of the Indian Government, and during the year 1864 the system had already been put into operation in a hundred public buildings, sixty of these being gaols. At Alleypore it has been applied to a gaol containing 1500 inmates, and at Mooltan to a gaol of 700, with very great success. And these are only isolated specimens of a movement which in an almost unprecedentedly short space of time became general. It will readily be conceded that a very manifest act of injustice would be done to the dry conservancy system if its merits were made to stand or fall by the success or failure reported from any one specimen of these Indian gaols; for it is to be recollected that the application of the system was made principally under the guidance of the paper read before the Society of Arts, to which reference has been made above; next, that the necessary measures were adopted on the spot, without any superintendence from those who were responsible for the system in England; and also, that in the case of so enormously extensive an adoption, a very considerable number of instances of faulty, or careless, or ignorant administration would necessarily occur. An experiment so general, and covering so vast an area, is, in common justice, to be tested, not by single cases, but by the aggregate result.

And the aggregate result was this: the Inspector-General reported on the system that it was, in his judgment, "the "greatest public benefit, without exception, ever conferred by a private individual in a matter so essential to public health." From military officers and civilians alike a cordial attestation was received in evidence of the great and general relief afforded. The Indian Government issued a Commission of Inquiry; and, on the reception of a report from that commission, the inventor of the system received from the Indian Secretary in Council a mark of official satisfaction and approval; and the Secretary of State for the Colonies directed a copy of the same report, together with copies of reports received from the Inspector-General, to be sent to the Governors of all colonial dependencies.*

In all cases, without exception, where a failure has occurred, it is submitted that such failure is distinctly traceable to hasty or erroneous application, contravening in some one or more important points the fundamental principles of the Dry Earth System.

II.

Application to villages, and in country districts generally.

In now advancing to the application of the Dry Earth System in villages, and in the farm houses and labourers' dwellings on estates, we approach a question of much more serious interest and magnitude than would appear on a first glance.

There is more than one point of view from which to examine this important subject; and it will be convenient here to regard it, first, in reference to health, and, next, in reference to economy, including under economical considerations the details of management and administration.

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* In Nos. XIII. XIV. of "Selections from the Records of the Madras Government," issued during this year (1869), a considerable number of official and medical reports have been republished, all more or less confirmatory of the system.

The sentiment of the picturesque has unquestionably given much support to the natural tendency to let things alone which prevails in every rural district, and which forms so grave an impediment, not only to the formation of clean and provident habits, but to the establishment of the simplest conditions of health. A deservedly high authority in agricultural science* has recently given a re-statement of this grievance, which will never be removed until daylight has been repeatedly and unsparingly brought to bear upon it. It has been, as he observes, so much the *custom* to regard the pretty thatched cottage of the village as the home of comfort and cleanliness, that the uninitiated are surprised to learn that fever and other contagious maladies are more readily associated with the picturesque thatch of the hamlet than with the unsightly slate and tile of the crowded town. In the meanwhile, more practical observers are well aware that behind many of the prettiest cottages there lurks a sickening malaria which, if detected in a town, would at once be dealt with as a nuisance. The ready seeds of disease are festering from one year's end to another in the outbuildings adjacent to the back door and windows. This state of things has, from long usage, become a matter of indifference to the owners of cottages, and a matter at any rate of habit to the labourer and his family. Trusting to the fresh air around them, they are contented to exist with confined and foul air within the cottage, and with a varied description of noxious matter at the threshold.

Death rate of villages.

The first and obvious consequence of this condition of things is, that the death rate of villages often runs alarmingly high. The Registrar-General's returns repeatedly show a much higher proportional rate in small villages than in large towns. For it must be recollected that malaria represents only one portion of the danger which besets village dwellings. The shallow wells, which are so generally the sources of water supply in a village, stand frequently in close proximity to cesspits; and when once the soakage from these has touched a well, an evil of the most serious character is called into operation. Occasionally the evil culminates. It was early in 1868 that public attention was called, forcibly and repeatedly, to the condition of the village of Terling, near Witham. In February of that year, typhoid fever had made such rapid progress there, that out of 900 inhabitants, 300 had been attacked, and 34 deaths had occurred. Precisely at the same time, the towns of Worcester and Tamworth were suffering widely under different forms of typhoid. A specimen of Tamworth drinking-water was submitted to Mr. Way, and was found by him to be "of a very dangerous character, the lowest proportion of solid residue being about five times as much as in the average of London waters." The fever at Terling was proved to depend upon exactly similar causes. The village was honeycombed with cesspools; and, though these might be repaired, it was unavoidable that the cement would be perpetually giving way, and that the surrounding soil and adjacent waters would be dangerously vitiated.

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* Mr. Bailey Denton in "The Agricultural Labourer" (No. 2), 1869.

The calamity which culminated at Terling is now impending, or is already in a lower degree felt, in an indefinite number of English villages and rural districts. And it is very essential to recollect that even the death-rate of such districts, ominous as it is, will be found to be no complete measure of the sanitary evils existing there. It is not only an excessive number of deaths, but a low standard of vitality, that mars the ideal perfection of picturesque villages. A low standard of vitality is traceable in the lassitude, physical and mental, often exhibited by the rural labourer; in an apathetic indifference to his own interests; and in the feeble resistance which is all that, in a large number of cases, his class are able to make against attacks of disease. Vitiated air, soil, and water are not the only agents that produce this low condition;

Low standard of vitality.

but it is inevitable that they should operate as very powerful agents indeed.

Few villages where a supply of water could be easily turned to sewage purposes.

Now, it is clear that, if cesspits are to be discontinued,* one of two courses must be selected. Either the sewage must be immediately and completely removed from the village, or a course of treatment must be adopted which will render it perfectly innocuous. There are not many villages in England that possess such a supply of water, capable of being so served, that the first of these processes could be worked successfully. Even were this condition reversed, reasons could be adduced, and certain economical reasons will presently appear, showing why this method of water removal would be an unfortunate one to adopt. But we prefer resting the argument on the simple matter of fact stated before, that very few villages in England possess a water supply which could be made available for sewage purposes. We are thus reduced to a method of treatment which no existing method provides so completely and efficiently as the dry earth closet. This system has been well described as the attainment, after years of spasmodic inquiry and experiment, of a safe means of dealing with village sanitary questions.

Earth system recognised by Sanitary Act of 1868.

The Sanitary Act of 1868 has now furnished a sound basis of operation, on which to proceed to the application of the Earth System. It not only recognises the earth-closet as an established agent, and empowers local authorities to supply earth when that may be required, but it contains provisions in virtue of which the benefits of scavenging may be secured to the smallest community.

Duties of a public scavenger under the system.

In regard to the Earth System itself, the duties of a public scavenger would be simple and completely unobjectionable. He would make periodical visits to the cottagers' dry closets, and see that earth is applied in proper quantities, and in a properly dried condition. He would further see that the soil, when mixed with the excreta, is removed to the cottagers' garden, or, where no garden exists, that it is taken away for use by others.*

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* Mr. Bailey Denton, ibid.

With these duties, it is obvious that he could unite an analogous supervision over water drainage, where that method might be still retained; so that the dry earth system and the water system could be made to work together in a village where a general adoption of the former could not be carried out.

But the work of the public scavenger would not terminate here. In addition to the obnoxious refuse which the Earth System treats, there are in all habitations the liquid refuse substances of the kitchen, the washhouse, and the chamber, to be provided for. Such provision may be made in two ways. The liquids may be either carried off by a system of sewers, the construction of which would be a light and inexpensive task as compared with the ordinary sewer which is made to convey solid and liquid refuse alike. Or, otherwise, they may be conveyed, by sub-irrigating drains, into the soil of the adjacent gardens, and there used as a valuable supplementary manure.

In the first of these cases, the public scavenger would superintend the measures necessary for the filtration, deodorization, and partial purification of the liquid substances, before they reach the street sewer. These objects would be aimed at by draining the liquids through some available medium, such as a compost heap, in which ashes would be a principal ingredient, and by the use of disinfectants where these might appear to be necessary. And, in the case of sub-irrigation, the scavenger would see that the necessary drains were in good repair, and that the sewage liquid was actually and effectively utilized in the gardens. This method has for many years been adopted with great success by the inventor of the Dry Earth System.

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* Mr. Bailey Denton, ibid.

Value of manure under the system.

With respect to the economical side of the questions affecting the Earth System, as applied in country districts, we cannot do better than quote, almost *verbatim*, an estimate from the authority to whom frequent reference has been already made, and whose calculations will be accepted as entirely free from tendency to over-statement. The money value of human excreta, when chemically tested and compared with the selling price of guano, is from 6*s*. to 8*s*. per annum for each individual. If the usual estimate of five persons to the family is taken, and if the whole refuse of a labourer's household is preserved for use by mixture with dry earth, the value may safely be put at the *minimum* of 30*s*. a year. The value of a good load of farm yard manure is 6*s*.; and it therefore follows that, in the sewage of his household, the labourer has the equivalent of five loads of farm manure, which is quite enough to maintain a rood of ground in the highest gardening condition, if, with reference to the cropping, it be applied to half the land each year.

This estimate has been given as being at once a valid argument in favour of the use of the Dry Earth System in rural districts, and a *minimum* calculation which no one will dispute. But it is only fair to add that a much higher estimate has been deduced from facts entitled to attentive consideration. We will confine ourselves here to the evidence furnished by the contractor for the supply of earth used in the Dorset County School. The operation of removal is conducted by him once in three months. He has tried the manure so manufactured on various crops, and considers its value to be, when dry, between 2*l*. and 3*l*. per ton. In the course of a year 42 tons are obtained, and, if the lower figure of 2*l*. be taken, the total value for the year will stand at 84*l*. The school contains about 80 boys, so that by this calculation the annual value of refuse for each individual would reach 20*s.* instead of 6*s.* or 8*s.*

III.

Applicability in towns.

We now have presented a condensed account of what the Dry Earth System has achieved, and of what in our opinion it is capable of doing, when applied to large institutions and to rural districts. The great question of town sewage remains. And, in discussing the applicability of the Earth System to towns, we must guard against a misapprehension that is not unfrequently entertained. It is often supposed that the advocates of dry earth are willing to represent themselves as prepared to deal at the present time with the sewage of all towns whatsoever, no matter of what magnitude or under what conditions they may be. Now, the engineers concerned in the promotion of this system are not so new to the difficulties and complications of the problems involved as to claim on behalf of any single method that it shall at once establish itself as an infallible solution. On the contrary, at a time when the treatment of sewage in towns of the first magnitude is in a completely empirical state, and when vast sums have been, and still are, expended on experiments of great extent, they would be satisfied to see dry earth fairly adopted and proved in towns of a small or moderate size. In the meanwhile, they would not resign or negative wider claims in regard to earth conservancy, but they would be content to hold these in abeyance, and to abide by the results of the development of the system within the more moderate limits just specified.

Colonel Ewart's report on towns in the Thames valley.

It has been before urged that, in the case of a method which runs counter to a large number of interests and usages, and which is remarkable chiefly for its simplicity and inexpensiveness, even a partial approval, from an official source, or from any independent quarter, is to be regarded as possessed of more than ordinary value. And we shall therefore offer no apology for introducing in this place certain extracts from Lieut.-Col. Ewart's "Report on the proper Principle of Drainage to be adopted in the towns of Oxford, Eton, Windsor, and Abingdon (1868)." The favourable verdict will speak for itself, and on those passages which take exception to the Earth System we will offer a few remarks. In Clause 33, Col. Ewart observes that—

His approval of the system.

"Earth-closets undoubtedly neutralise, most efficiently, the nuisance arising from human excreta, and make their removal a question of ordinary mechanical transport; and it is impossible to rate too highly the beneficial effect of their adoption in cottages, detached buildings, hot climates, and, in short, any place where a supply of water is deficient or difficult of attainment."

Col. Ewart then proceeds to state that, in his opinion, the suitableness of earth-closets to towns is a question of a different character. And, in Clauses 35—40, he lays down the following propositions:—

His objections.

That it would be difficult, if not impracticable, to combine water and earth as systems of operation in "the same part of a town."

That water drainage must be provided for the exigencies of an existing water system; that, this being the case, little would be gained by excluding from the drains the obnoxious refuse of a small portion of houses; and that a separate system of scavenging for these houses alone would be an expensive concern.

That doubts may arise about the certainty of an earth supply for a large population, and about the feasibility of removal.

That doubts may also arise about "the relative expense of carrying earth to the excreta instead of carrying the excreta to the earth by water-carriage," regard being had to the removal of the refuse liquids, which cannot practically be done on a large scale, except by foul drains.

And that, therefore, earth-closets cannot be advantageously used, except in certain detached parts of towns, and in certain other places where water supply may be difficult, or water drainage obstructed; but that, in such quarters, the dry system "may be employed, at least temporarily, with advantage."

With reference to these propositions we proceed to subjoin a few observations.

Discussion of his objections.

It is perfectly true that, if the water system be adopted, water drainage must be provided, and that not much would be gained by excluding from the drains the obnoxious refuse of a small portion of houses. But, on the side of the Earth System, it is contended that no cause, sanitary or economical, can be shown for the requirement of water at all for the main system of drainage in ordinary sized towns and large villages. It is notorious that in a great number of such places there exists an ample water supply from the wells attached to each house, or from public wells or springs, and it is clear that in such places water works are not wanted for the sake of the water, but the large expense incurred on their account is, so far as water alone is concerned, unnecessary. It is nothing to the purpose to suggest that these wells may be contaminated, since the adoption of the Earth System would effectually prevent existing contamination, and make its future recurrence impossible. In such towns, therefore, water works would be devoted to no other purpose but one which is here maintained to be as unwholesome and uneconomical in its operation as it is costly in organisation and adjustment. We mean the forcing through drains, by means of water, of the whole sewage, liquid and solid, of a town. And while it is undoubtedly true that small gains would follow on excluding from a system of water drainage the solid refuse of only a small number of houses, we respond that everything would be gained by excluding from these drains the whole solid refuse of the town. It should be added that the small system of drains required for the liquid refuse, if earth were applied to the extermination of the solids, would not require more than one-third of the cost bestowed on drains under the water system.

When Colonel Ewart speaks of the expense of scavenging, he is obviously contemplating a scavenging apparatus over and above an existing water drainage. But we may avail ourselves of this opportunity to remark that the expenses of scavenging under the Earth System must always be discounted by credit given for the profit arising from the manure.

Regarding the certainty of an earth supply, that is a question of local consideration. No engineer would undertake to pronounce a constant supply of earth to be certain in the case of a town which he had not inspected, any more than he would guarantee a constant supply of water. But one point may be regarded as positive and certain, namely, that from the day when the neighbouring farmers began to appreciate the value of the manure—and that is a value which they are not slow in estimating rightly—the local board in any town whatever would experience no difficulty in obtaining an ample earth supply. Convincing evidence in proof of the feasibility of removal in towns has been furnished by the case of the Dorset County School, an institution to which reference has already been made, and which is at present situated in the High Street of the county town.

When Colonel Ewart speaks of the relative expense of carrying earth to excreta and the excreta to the earth, he is apparently speaking of two cognate processes, opposed to each other only in point of sequence. But this is far from being the real state of the case. So far from the processes being kindred ones, they are essentially and fundamentally different. By the application of earth to the refuse substances, on the principles involved in the conservancy system, those substances are rendered innocuous, and, on being absorbed into and amalgamated with the earth, they are capable of innocuous removal and economical use. On the transportation of the same substances to the earth by means of water carriage, their deleterious nature is in many cases not perceptibly diminished. In no case is it, or can it be, destroyed or removed. And, by this system, instead of wholesome conveyance and economical use, we have considerable risk and danger in the conveyance and an unremunerative application. The earth is denied the exercise of her own sanitary properties, and she is refused the benefit of those substances which, when properly acted upon, are remarkably stimulative to production, but which when drenched and imported *en masse* are useless, if not dangerous.

Colonel Ewart has admitted that the earth system may be advantageously employed where water is at a *minimum*. And therefore, having regard simply to the merits of that system itself, we venture to assert that he has made no valid allegation against its use where water is at a *maximum*. We have only further to observe, in reference to his Report, that, whereas he has expressed a doubt about the drainage of stables and similar buildings, where the Earth System is adopted, he is here speaking without an acquaintance with the facts. Remarkable success has attended the application of earth in the case of stables, cowsheds, piggeries, and farm buildings of that description, and the most wholesome effects have followed.

Supply of earth should be undertaken by Local Boards.

The supply of earth, in any town which might adopt the system, should be undertaken by the Local Board of Health, and all necessary measures should be superintended by their officer. As a water system could not exist generally throughout a place of any considerable size without a supply of water regularly furnished, no more can the Earth System without a supply of earth. And in effecting this object, no difficulty, trouble, or cost will be experienced, bearing any comparison with what is now encountered by the adoption of the water system. The economical uses which have been shown to be possible under the Earth System, and the many expenses entailed under the other system by the frequent bursting or stoppage of pipes in winter, and the many necessary repairs, are considerations sufficient of themselves to establish this point.

Comparative cost of earth and water.

The comparative cost of the two systems, when applied in towns of moderate size, has been ably and forcibly illustrated as follows.

To carry out the water system in a town of moderate size, the public works alone would require an outlay of between 12,000*l.* and 15,000*l.* The water supply, of which the greater portion goes to the domestic sewage and the flushing of the sewers, will be daily not less than 300,000 gallons, or about 1370 tons, for a population of 7000.

On the Dry Earth System, the public works would consist, not of deep, large, and costly drains and sewers, with costly pumping apparatus for flushing, but of surface drains, which will often be found already existing for the rainfall; and perhaps of very small drains just below the surface for the sink water. Instead of 1370 tons of water raised and distributed daily at a considerable cost, 10 tons of earth would be found amply sufficient. And, as the same quantity of earth would admit of at least three uses within the year, the whole annual requirement would not go beyond 1000 tons. It is worth while, as we need scarcely observe, seriously to contrast the daily consumption of 1370 tons of water with the annual consumption of 1000 tons of earth. Nor must it be forgotten that, while the water effects a waste even if it does not do worse, the earth promotes health and produces a profitable return.

Milanese system costly and complex.

The comparative details just mentioned bring out into strong relief the simple and inexpensive character of the Dry Earth System as contrasted with every other scheme that has been suggested for the sewage of towns. A good deal of attention has recently been bestowed upon the method adopted in the city of Milan, which, as it is an attempt to work back on the old tracks, and to conduct the abandoned system of cesspits on sound principles, may be allowed the merits of boldness and ingenuity. By the Milanese method, which has also been partially introduced in Paris, the sewage matter is conducted into receptacles, air-tight and water-tight, and is removed thence by special carts provided with vacuum reservoirs into which the sewage is drawn up through pipes for conveyance to the neighbouring country. This agency, as we have already said, is bold and ingenious; but costliness is not the only consideration in regard to which it stands on a footing far inferior to the Earth System. It is not our opinion, but that of Colonel Ewart, that no scheme of town drainage can be recommended which is dependent on mechanical arrangements of great complexity, and in which serious risks to health would be incurred if any fracture or defect were to arise in the machinery used, or any of those failures were to happen which are necessarily incidental in practice to such a scheme.

The questions of expense and of the pollution of river-waters are closely connected together. For it can be shown, as all ratepayers who have considered the subject are well aware, either that the adjacent waters to a town, and very probably also waters at a distance, seldom taken into the account, must be vitiated and polluted by its sewage, or that an expense must be incurred which is out of all proportion to what a civilised community ought to be paying for the attainment of the object in view.

The pollution of river waters.

The subject of tainted river-waters has now for some time been regarded as a question of national magnitude. The condition of the Thames produced the Thames Navigation Act, which interposed to necessitate the distribution of sewage over land in such a way as to attempt the purification of the liquid before allowing it to enter the stream. Until that Act was passed, the Thames, before reaching the point at which its supply of water for London was obtained, received the sewage and drainage of towns and villages containing more than seven hundred thousand inhabitants. The Medlock and Irwell at Manchester, the Mersey at Stockport, the Tame at Birmingham, with a large number of waters similarly connected with towns of great size, were recently, and probably still are, in a condition considerably worse than that of the Thames. And there is a special case in the North of England, which can hardly be passed over without particular mention. The river Calder receives through the Hebble a large quantity of the sewage matter of Halifax, a borough containing a population of 30,000. As the Calder flows on to Wakefield several other places discharge sewage matter into its waters, until at Wakefield it receives the refuse of a population of 26,000. Four miles only below this town, a water company pumps the water to be sent back into Wakefield, filtered, for ordinary consumption!

Systems of irrigation.

Now, while we are perfectly free from intending any systematic attack upon the various systems of irrigation which are at present on their trial, we call attention to the fact that these systems of protection for rivers are eminently and disastrously expensive. It is quite open to urge the reply that no expense can be too great when the object is to ensure human life and health. But this plea carries little weight. The value of life and health is no doubt incalculable, but the cost of preserving life and health on intelligent principles is a matter of calculation and estimate, and this estimate, as we maintain, is habitually exceeded to a very large extent.

Without canvassing either the "joint" or the "separate" systems of drainage in detail, it may at any rate be observed that, beyond the prime outlay, which is itself abnormal in social economics, the first system is weighted with additional current expenses from its liability to deranging accidents, and the other from its complexity. By the "joint" system all the rainfall which descends on the drainage area is carried into the same sewers as the sewage matter. The surface waters are thus perpetually carrying into the sewer fine sand and other street material, which, combining with the sewage-refuse, often forms a mass that has to be removed with much trouble and expense. The effluvium from this mass often finds its way into the streets through the openings for the passage of rainfall or supply of fresh air; and, where traps are ill-constructed, foul gases force their way into dwellings. Besides which forms of mischief, the mixture of rainfall with sewage matter makes the quantity of liquid issuing from the outfall a matter of complete uncertainty, and hence in low-lying neighbourhoods of grave and repeated annoyance.

Without alluding further to the complexity of the two sets of drain-conduits required under the "separate" system, in which the rainfall is kept distinct from the sewage matter, we may remark on the score of expensiveness that Colonel Ewart advocates the rental by the town authorities of not less than one acre for every 100 of population for the disposal of sewage under this system, which is the method of his choice. A town of 7000 inhabitants would thus require an area of 70 acres to be secured for their use, in addition to the large prime expense of public works, and the long array of incidental cost subsequently incurred.

Concluding summary.

On behalf of the Dry Earth System we now draw together the claims which have been briefly explained in the foregoing pages. We submit to the consideration of local health authorities, and of the large class of landowners and other practical men who have an immediate interest in the important issues involved:—

That the Earth System is not now before them as an untried agency;

That in a conclusive number of large institutions, and on a scale of conclusive magnitude in the Camp at Wimbledon, its feasibility has been severely tested and fully established;

That its applicability in rural districts, which is a point most generally conceded in its favour, is strengthened by the circumstance that earth is the only possible agency that, in many such districts, can be brought to bear upon the mitigation or removal of existing mischiefs;

That in towns of small or moderate size, there is no obstacle whatever in the way of the immediate application of this system, which might be efficiently worked by the local authorities acting on their own account, or by a company subject to their control in certain respects;

That the experience gained by the adoption of the system in such places may be reasonably looked upon as likely to aid materially in the solution of sanitary problems affecting towns of the first magnitude;

That, whether applied to institutions and large aggregates of men, or in country districts, or in towns, the advantages of the Earth System are entitled to the gravest consideration;

That the evidence which has been adduced, and which is constantly and rapidly increasing, places its sanitary soundness and efficiency beyond doubt or question;

And that, on each and all of these considerations, the advocates of the Earth System are justified in claiming that it shall take its proper place as a recognised agency, fairly competing on common ground with the older and more familiar methods.

APPENDIX.

SINCE the foregoing pages were written, the Volunteer Camp at Wimbledon has again been formed, and again the Earth System has stood the test successfully. There were altogether 170 Closets and Urinals, and these were used, on average, by not less than 5000 or 6000 persons daily. Earth Closets were also erected at the lavatory and ladies' cloak-room, and were used by a large number. Of course, after the controversy which took place as to the diarrhœa of last year, and the doubts thrown upon the soundness of the System, we were naturally somewhat anxious, and we made it our particular request to Surgeon Wyatt that no disinfectants should be used, but that the earth should be tried and stand upon its own alleged merits. He kindly consented; and nothing was used, either in or about the Closets. We have great pleasure in printing the following letters addressed to the "LANCET" of the 24th inst.; one from Surgeon-Major Wyatt, and the other from Captain Drake, Engineer Officer in Command of the Camp:—

"THE WIMBLEDON CAMP.

"*To the Editor of* THE LANCET.

"SIR,—

"In forwarding for insertion in your journal the accompanying detailed report of the cases requiring medical assistance during the period of the late meeting of the

National Rifle Association, I have also appended some independent observations upon the practical working of the dry-earth closet system from the officer commanding the Royal Engineers, who, from very considerable experience, and most thorough knowledge of this particular subject, is conversant with all its scientific bearings; and I have the more satisfaction in asking you to insert Captain Drake's opinions and recommendations, because they are completely in unison with the views I took the liberty of bringing to the notice of the profession in your journal of the 3rd inst.; and I think I am justified in the statement then made, that I did not consider the excessive amount of severe diarrhœa which prevailed last year, when the earth closets were first employed, was in any way to be associated with the system, but was probably due to the great solar heat and the unwholesome beverages indiscriminately consumed. During this meeting a better surveillance of the closets has been insisted on, and they have been used to an enormous extent by the vast concourse of people assembled; but I have heard of no complaint of any want of deodorisation; and certainly the 39 cases of diarrhœa which have been recorded were of a very trivial nature, and, strange to say, there were precisely the same number of cases treated for constipation. The flying column also, from the Aldershot Division, which numbered upwards of 3000 soldiers, and remained in this camp for three days and nights, besides undergoing the fatigue of a very exhausting field day, only recorded two cases of slight diarrhœa; but ordinary camp trenches were dug for their use, those of the earth closets being quite full, and therefore closed up by my order. I may also mention that once during the meeting the pits were emptied of their contents with no objectionable result, the night being, of course, selected for the operation. I can safely venture to affirm that this camp is, of all places, perhaps the most suitable for thoroughly testing the value of this important sanitary invention, which has well borne the ordeal.

"There was but one solitary casualty in connexion with the field day operations of the 17th. A young medical officer of a Volunteer Artillery regiment received a severe contusion of the superior maxilla, dislodging several teeth; but he was able to leave the camp the same evening.

"I am, Sir, your obedient servant,

"JOHN WYATT,

"Surgeon to the National Rifle Association."

DETAILED MEDICAL REPORT,

For the period from the 5th to the 17th of July, 1869.

	Average number sleeping in camp.	Diarrhœa.	Dyspepsia.	Constipation.	Bronchitis.	Tonsillitis.	Rheumatism.	Febricula.	Debility.	Inflammation of eye.	Epilepsy.	Skin disease.	Boils.	Contusion.	Burns.	Dog bite.	Gunshot accidents.	Treated in camp.	Treated in hospital.	TOTAL.
Army . .	670	...	1	5	...	1	...	...	..	...	...	...	1	8	...	...	1	17	...	17
Volunteers .	1071	21	9	9	...	6	3	1	2	4	2	1	1	10	...	1	...	61	9	70
Police . .	265	5	2	5	...	...	...	...	...	...	...	...	...	6	...	...	...	17	1	18
Camp followers	419	13	6	20	2	3	1	1	5	4	...	1	3	10	2	...	...	71	...	71
Total .	2425	39	18	39	2	10	4	2	7	8	2	2	5	34	2	1	1	166	10	176

Camp Hospital, Wimbledon, July 18th, 1869.

"THE DRY-EARTH CLOSET SYSTEM.

"*To the Editor of* THE LANCET.

"I CONSIDER this the best system known for military latrines, when a supply of suitable earth is obtainable. In introducing this system into barracks or permanent camps, I should attend to the following points:—

"*Earth.*—This should be a clayey loam, friable, and thoroughly dried. In 1868, at Wimbledon, a sour smell was perceived, which was found to proceed from the peat earth, the fibrous portions of which had fermented with the great heat.

"*Apparatus.*—That used by the Moule Company answers very well, especially now that the engineer has introduced the simple means by which the earth is properly distributed in its fall.

"*Vaults.*—These should be lined with brick, in cement, asphalte, or other water-tight lining, to exclude leakage from the surrounding soil, as the system ceases to be effectual when it ceases to be a dry-earth system.

"*Place.*—I should recommend building latrines back to back, with sufficient space between for the earth to be supplied and removed as necessary. In building a single row of latrines, as in the case of a row of cottages, the earth should be supplied, and the manure removed, from the outside, the inhabitants having no means of access either to the earth houses or the vaults.

"*Urinals.*—These should be entirely separated from the latrines. The supply of earth should be given by hand, no self-acting apparatus being found to answer. Pioneers should go round twice a day at least, and supply the amount of earth required, care being taken that the layer supplied at any one time should not exceed three inches in thickness. The part of the urinal liable to be watered against should be of slate rubbed smooth, *but not enamelled.* This is found to resist the action of urine better than any other material.

" *Washing water.*—The refuse water from kitchen sinks, &c., should be drained into cesspools accessible to a cart in the same way as the latrines. It can then be pumped into a cart and removed. It would be very valuable for garden purposes.

" I believe that when the value of the manure becomes better known, there will be no difficulty in finding contractors to supply the dried earth and remove the soil and sink water, paying fairly for the privilege.

" MERVIN DRAKE,
" Commanding Royal Engineers at Wimbledon.

"CAMP, WIMBLEDON,
July 18."

These letters speak very clearly as to the practical utility of the Earth System, and surely dispel all doubt as to its sanitary effect. But anxious to place this beyond doubt, we have employed a skilful and experienced chemist to investigate the subject, and we subjoin his report, received within the last few days :—

"TO MESSRS. GIRDLESTONE,
"*Engineers to* MOULE'S PATENT EARTH CLOSET COMPANY.

"I have been engaged for some time past upon certain minute investigations connected with the important question of deodorisation of fæcal matter by means of Dry Earth.

"I have likewise carefully read through the late controversy (as reported in the '**Lancet**') between Dr. Geo. Rolleston, of Oxford, and the Rev. Henry Moule, but was surprised to find such a scarcity of *practical* evidence on the part of one who seems to object so strongly to the Earth Closet System.

"Dr. Rolleston published an account of his experiments with dry earth in contact with fæcal matter; and although he found that the mean of those tests afforded results *favourable* to the '*System,*' still he condemns the latter simply upon theoretical grounds.

"Now, if I take it aright, the real and simple questions at issue are as follows:—

"1. Does fæcal matter decompose in contact with dry earth?

"2. If so, what is the nature of the various products of decomposition?

"3. Does hydrated silicate of alumina and mould thoroughly absorb all or any of these products?

"As regards the first question, little need be said in answer. Every scientific man must admit that fæces, *at the time of deposition,* are in a state of transition or decay; and as regards my own experience of the manure from the Earth Closets, as obtained by repeated analyses and careful examinations, I have always found a most intimate union of the organic and mineral constituents, together with the entire absence of *smell.*

"*Secondly,* as regards the *nature* of the products of decomposition. Of these we have found *ammonia* and volatile compounds of ammonia, such as the carbonate and hydro-sulphide, together with carbonic *acid* and *oxide,* and certain odorous organic vapours, of the composition of which we know nothing.

"Now, does earth absorb any or all of these? I have tried experiments similar in nature to those of Dr. Rolleston, viz., by passing a current of *purified* air, by means of an '*aspirator*,' slowly and for a protracted period over mixtures of fæcal matter and dry earth, and afterwards testing the same for carbonic acid, and by Nessler's test for ammonia, as well as by the usual test for *alkaline sulphides*, and the conclusion at which I have arrived is this: That dry earth is for the deodorising of fæcal matter the best substance that can be used for the purpose.

"My first experiment was made with a coarse sample of the Wimbledon clay (previously dried); but, on account of the size of the lumps, *perfect* deodorisation *was not* effected. The experiment was repeated with the same sample fairly pulverised, affording most satisfactory evidence of its power to absorb noxious effluvia.

"Again, I found that the earth had a *better* deodorising action when only *partially dried;* a small quantity of moisture, viz., about ten to fifteen per cent., was beneficial, acting probably as a carrier to the soluble gaseous products of decomposition. Again, I found that samples of earth containing clay were more effectual for deodorising purposes than purely vegetable mould, although the two may be most judiciously mixed.

"Now, as regards the '*malaria*' and '*miasma*' producing vapours, spoken of by Dr. Rolleston in the number of the 'LANCET' for March 6, 1869, I would ask, where is there any *practical proof* of the existence of such exhalations arising from the Earth Commode? And again, if dry earth thoroughly and effectually absorbs so *diffusive* a gas as ammonia, or else the still more penetrating *odours* that arise from decomposing fæces, is it not reasonable to infer that other organic vapours could be as effectually arrested?

It has been proved by the most able and scientific men that earth in contact with *manuring agents* not only *absorbs* but actually decomposes their constituents, causing most complex union and reunion.

"The Earth Closet System, when *used,* and not *abused,* is, in my opinion, deserving of all support.

"GEORGE JONES, F.C.S."

"106, LEADENHALL STREET,
"15*th July*, 1869."

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